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Hardware control systems using Java

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Abstract

The purpose of this thesis is to apply Java technology to facilitate the creation of more reliable, portable, flexible and logical hardware control systems. This has been achieved by integrating Java tools and libraries throughout the development processes of several software projects.

In particular, the development of enhancements to the Automated Patrol Telescope control software was conducted. The Java language has been used to develop both sophisticated user interface and hardware control components utilising protocols such as the Simple Network Management Protocol. These enhancements have been seamlessly integrated into the Java Automation System to provide distributed control of the Automated Patrol Telescope.

The Spectrum Scanner application has also been developed in Java to provide software control of a radio receiver through the RS232 Serial protocol, capable of data visualisation using the VisAD toolkit.

This thesis documents these achievements and presents the possibility of integrating these advancements with other systems in the future.

Acknowledgements

Special thanks must be extended to my supervisor, Michael Ashley, and to Keith Bannister for their consistent patience and assistance throughout the year. Thankyou, also, to my SEARFE colleagues, Michelle Storey and George Warr.

Most of all, thanks to all my family and friends for their help with just about everything. Everyone who has helped out is included in the puzzle below (names can be found up, down, right, left, and diagonally).

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1 Introduction

1.1 Overview

This thesis documents the application of the Java language across several projects, the majority of which, are dedicated toward the Automated Patrol Telescope. However, much of the technology developed as part of these projects can be applied to other similar hardware control systems.

1.2 Automated Patrol Telescope

These Chapters document efforts made to improve various software systems resulting in a more reliable control system for the Automated Patrol Telescope. The APT is an optical telescope managed by Michael Ashley and the UNSW school of physics.

- Chapters 2 and 3 provide a very in depth coverage of the existing hardware and software currently used to provide the automation capabilities of the telescope. A significant effort has been made to clearly document these systems to allow students in the future to more easily understand and assist in its further development. Appendices A through E are also very useful resources in understanding the APT system.

- Chapter 4 thoroughly documents the design and implementation of the `apt.masterswitch` software enabling complete control of the APC Masterswitch device.

- Chapter 5 covers the features and implementation details of an improved client user interface to the APT utilising the JAS.

- Chapter 6 documents design decisions and implementation level details of an automated software deployment system for the APT, integrating version control and

1.3 Additional projects

- Chapter 8 covers the design and implementation of the reusable SkinnedTextField GUI component, designed to display telemetry information in high quality user interfaces. This component is used in both the APT client application and the Spectrum Scanner software

- Chapter 9 introduces the Spectrum Scanner software, designed to control a radio receiver and provide data acquisition, visualisation and analysis tools. This software was developed for the SEARFE (Students Exploring Australia's Radio-Frequency Environment) project run by the CSIRO.

2 APT hardware

2.1 Introduction

The APT is a term often used not simply to refer the Telescope itself, but rather to a complex system of integrated components. As a *system*, these components interact to provide comprehensive software remote control of the telescope and its environment.

This Chapter provides an overview of the devices and how they interact to provide automated control. The APT architectural diagram, shown in Figure 2-14, is a useful aid in understanding the content of this Chapter.

2.2 APT building

Figure 2-1 APT building

The APT is situated at Siding Springs observatory, Coonabarabran and housed in a small building. More precisely, the APT is at 31º16'30" S, 149º03'40" E and an altitude of 1140 meters above sea level.

Control of the sliding roof, discussed in more detail in 2.10, gives the telescope rapid access to any part of the sky. The building also contains a control room, adjacent to the telescope, where much of the computer equipment is located.

2.3 Mistral

Mistral[i] is an Intel desktop computer running the GNU Linux operating system which runs the majority of the software used to control the telescope and other devices inside the building. Currently mistral is a 450MHz Intel Pentium III, 384MB Ram, with approximately 100GB of hard drive space. It is also equipped with a SCSI CD/RW burner, and an IDE DVD Burner[ii], primarily for distributing and archiving image data.

Mistral is part of a local 10Mbit subnet shared by all of the Ethernet devices at the site. 2 x 64 Kbit/s ISDN lines provide a gateway to the Internet.

2.3.1 Serial modem

A standard 56K modem is installed to provide a *Phone Alert System*, proposed and partially implemented in (55). This phone alert system is ultimately designed to place a voice call to a qualified technician in an emergency situation and provide them with specific information.

2.3.2 USB sound card

Mistral is also interfaced to a *Telex Pro* USB sound card. Designed to provide voice messages to warn people nearby of activity at the site. The remote operation capabilities of the APT, and the fact that the control room is likely to be unattended, presents several safety issues. Unexpected roof operation, for example, could cause serious injury to unaware bystanders.

Software is currently in place to produce these audio messages, however, additional hardware is required to provide sufficient volume for the system to actually be effective.

2.3.3 Watchdog

A *PCI PC Watchdog, from* (3), board is installed in mistral to monitor the PC's temperature and software to provide maximum availability. The watchdog device driver also routinely attempts to poll the card, in order to prevent the card from assuming the operating system has failed and subsequently reboot the computer.

2.4 Telescope

The telescope, shown in Figure 2-2, is a wide-field, 0.5m[iii] Schmidt[iv] optical telescope fitted with a CCD camera for imaging.

---

[i] mistral.anu.edu.au: by convention, all hostnames within the Research School of Astronomy and Astrophysics at ANU begin with the letter *m*

[ii] currently only utilised as a CDR-RW driver due to device driver limitations

[iii] 50cm aperture

[iv] *Schmidt* is a standard telescope design

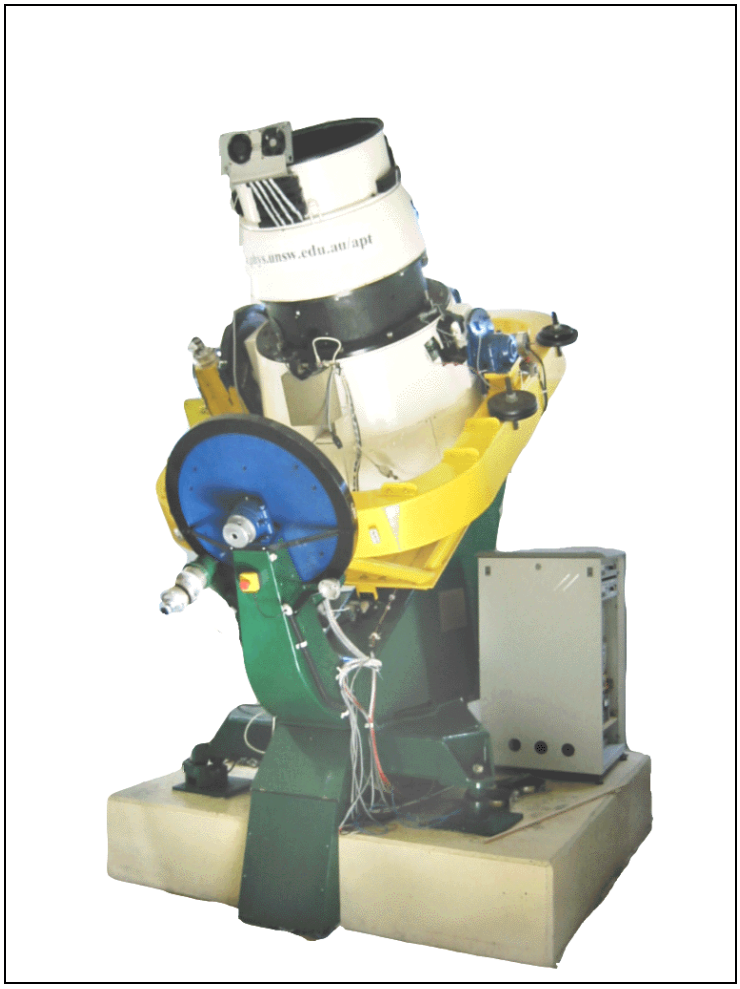


Figure 2-2 Telescope

Originally a Baker-Nunn satellite tracking camera, the telescope was donated to The University of New South Wales by the Smithsonian Institute in 1986. Since then, it has been significantly modified. The optics were redesigned to allow the use of standard 5-mm astronomical filters (see Appendix E.4), and also to produce a flat focal plane. This is discussed in more detail in Appendix E.5.

Currently the telescope is fitted with a green 'V' filter. Changing filters is a complicated process and it is desirable to automate this function in the future, as suggested in Chapter 7.2.1.

There is also a 110V mirror heater installed to prevent the build-up of dew within the optics of the telescope.

Most professional telescopes, such as the nearby 2.3m[i], are designed to view an area approximately 0.1º x 0.1º of the sky. The APT, however, is a wide-view telescope with a viewing area of 5º, although, due to the current limited size of the CCD installed, images are only 3ºx 2º[ii]. In the future, a newer CCD camera will be installed capable of utilising the full viewing area of the telescope.

[i] 2.3m diameter primary mirror
[ii] 3 degrees (E-W) x 2 degrees (N-S)

2.5 CCD

The CCD, or *Charge Coupled Device*, is a digital camera, similar to those commonly found in the marketplace today. The telescope is equipped with a *Wright Instruments* CCD camera with a resolution of 1152 x 770 pixels (digitised at 16 bits/pixel). The CCD is controlled using a Linux character device driver developed by Michael Ashley.

2.5.1 Focus control

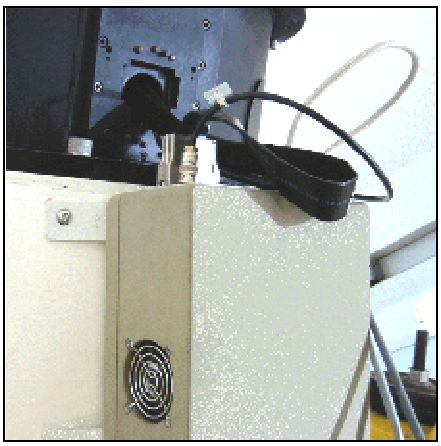


Figure 2-3 Focus motor interface

Focus is achieved by adjusting the distance of the CCD from the primary mirror inside the telescope. This is achieved by using a *stepper motor,* controlled via the *focus motor interface*, shown in Figure 2-3. Software manipulates this interface through the `/dev/focus` device special file.

Two limit switches (upper and lower) are also installed to prevent damage to the focus mechanism.

2.6 Telescope movement

Astronomers use the equatorial coordinate system to describe the position of an object in the sky according to its right ascension and declination. This is discussed in more detail in Appendix E.1.

In order to simplify the calculation of these equatorial coordinates, the mount itself has been aligned with the earth's North – South axes. A viewer standing in the control room looking toward the telescope is facing directly South.

The mount itself can be rotated on two axes:

- *Right ascension* (RA) aligned with the North – South axis
- *Declination* (Dec) aligned with the East – West axis

There are two *pancake* servo motors, one for each axis. The RA motor, shown below in Figure 2-4, uses a harmonic gearbox and a friction drive to provide rotation, resulting in a very accurate control of the axis.

Unlike the RA axis, the declination motor (Figure 2-5) rotates its axis via a worm gear. The anti backlash motor, discussed in 2.6.1, is required to eliminate backlash..

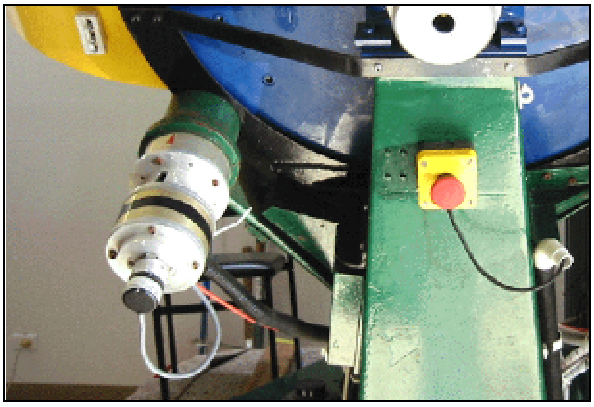


Figure 2-4 Right ascension motor

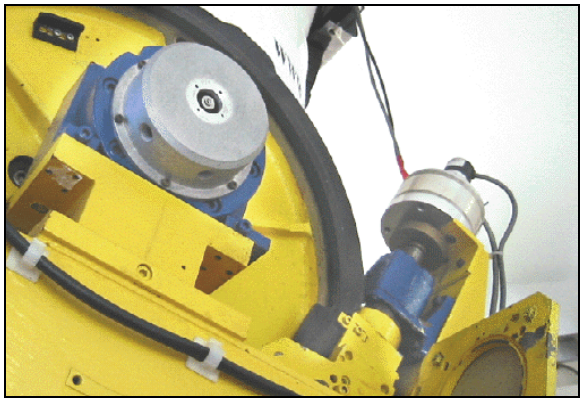


Figure 2-5 Declination motor

Each servo motor is powered by its own DC servo amplifier which receives an analogue voltage from the *Macrostation* (see 2.6.4).

In October 2002, the motors were upgraded to improve the average telescope slew time from approximately 120 seconds to 30 seconds for a 100 degree slew.

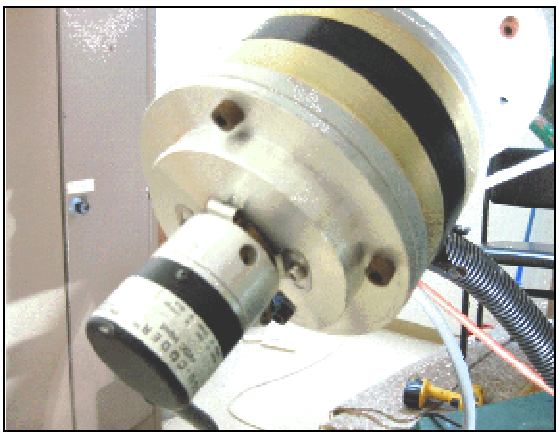


Figure 2-6 Incremental encoder

Connected to each motor, is an *Incremental Encoder* (Figure 2-6), which is used to accurately measure the shaft rotation.

Once calibrated, the information from these encoders is used to calculate the coordinates of the telescope.

Also in October 2002, newer encoders were installed providing a higher resolution of 10000 pulses per revolution, four times higher than the old encoders.

2.6.1 Anti backlash motor

The Anti backlash motor is required on the declination axis in order to compensate for the backlash caused by the use of a worm gear, rather than a friction drive system, as used in the right ascension axis.

The declination motor, is mounted perpendicular to its axis (as shown in Figure 2-5). Consequently, a worm gear is used to correctly transfer the motion of the motor to the main gear.

The slack space between the teeth of these gears results in a backlash. This is particularly noticeable when the motor changes direction, a small amount of motion on the motor will result in no movement of the telescope. Also, the telescope mount can be moved freely by physically

pushing the mount in the opposite direction to which it is travelling. Note that this motion will not be recorded by the software, which only monitors the encoders attached to the motor shafts.

In order to compensate for this slack space, the anti-backlash motor, show in Figure 2-7, provides a constant tension in one direction, forcing the worm gear to remain in contact with one side of the main gear, eliminating any free movement of the telescope mount.

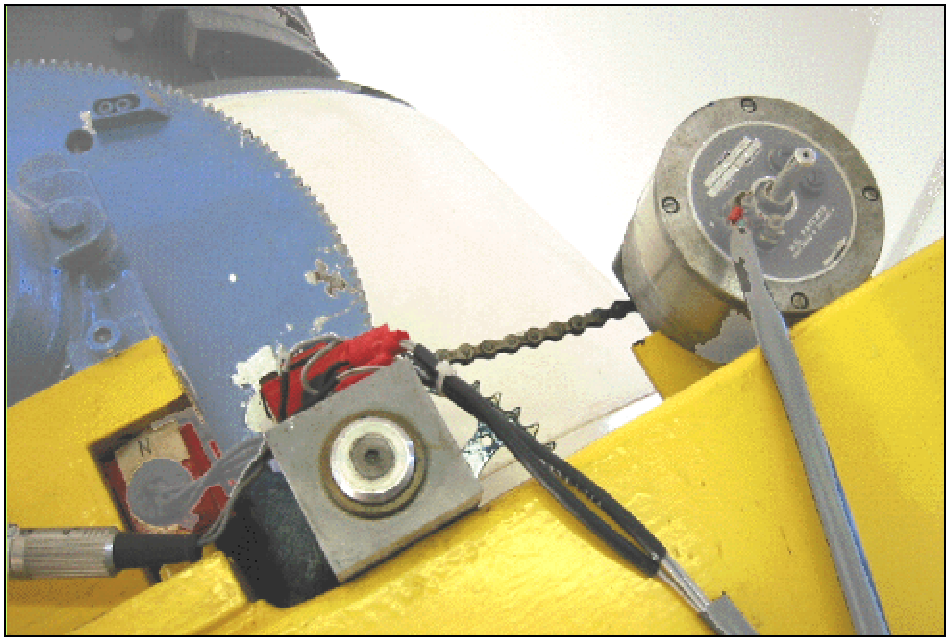


Figure 2-7 Anti backlash motor

For this reason, during normal operation of the telescope, the anti backlash motor should always be powered on.

2.6.2 Limit switches

Limit switches are used in order to prevent the telescope from damaging either itself or any other equipment in the enclosure by travelling too far.

Four switches are used for each axis:

- 2 inner limits
  These provide digital inputs to the Macrostation. When triggered, the software is notified via the PMAC (see 2.6.4) device driver should take measures to stop the telescope moving further.

- 2 outer limits
  Triggering the outer limits will cause the corresponding servo amplifier to cut power to the servos, preventing the telescope from moving.

The Inner (software) limits restrict the range of the declination axis from -75º to 29º55', and the right ascension axis to approximately 4.5 hours either side of the meridian.

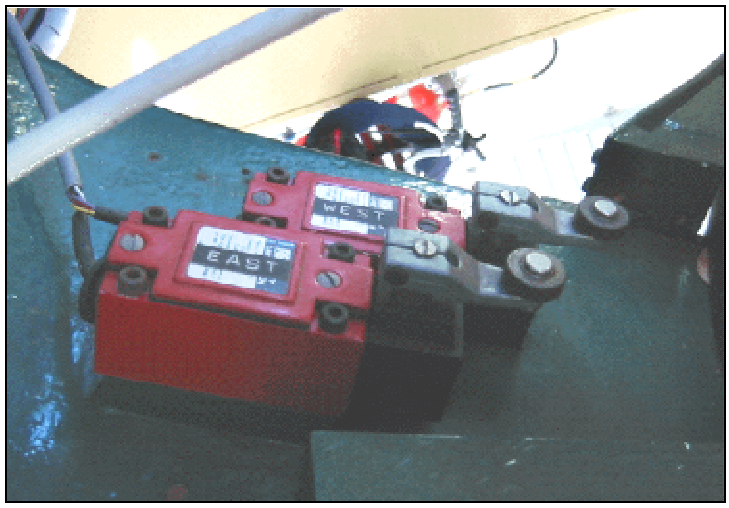


Figure 2-8 Inner RA limit switches

2.6.3 Tilt sensor

The tilt sensor is used for calibration of the telescope. This is necessary to correctly interpret the data from the encoders, the encoders can only count the amount of movement or each axis. This information is meaningless unless used in conjunction with a known reference point.

The tilt sensor has two digital outputs indicating if the telescope is east or north of the zenith. As shown in Figure 2-14, these outputs are connected to the Macrostation and controlled via the PMAC device driver.

2.6.4 Macrostation

The MACRO (Motion And Control Ring Optical) – Station is a microprocessor based controller, manufactured by (1), used to process the information from the encoders, tilt sensor, limit switches, and allow software to control the RA and Dec axes.

The PMAC (Programmable Multi Axis Controller, also from (1)) interface board, installed in *Mistral,* is controlled via a Linux device driver[i], developed by Michael Ashley. The Macrostation is connected to the PMAC[ii] via a high speed fibre optic network.

The PTCS software system, discussed in Chapter 3.2, in conjunction with the PMAC software is used to abstract this hardware implementation and provide telescope control.

[i] /dev/pmac
[ii] A PCI card in *Mistral*

2.7 Masterswitch

Figure 2-9 APC Masterswitch power distribution unit AP9212

In principle, the Masterswitch is a very simple device. It allows software control of eight 240V power outlets. Currently, the Masterswitch is responsible for supplying power to the following devices within the APT enclosure.

1. Anti-Backlash Motor
2. RA Servo
3. Dec Servo
4. Macro Station
5. CCD Camera
6. Lens Fan
7. Room Lamp
8. Infra-Red Lamp

The Masterswitch power is sourced from the UPS.

2.7.1 Masterswitch control

There are two devices build into the Masterswitch to facilitate control:

- An RS232 serial port (Control Console)
- APC Management Interface Board

The console is primarily intended for initially configuring the device. The APC *Management Interface Board* provides a much richer set of functionality via a network connection. Once it is configured with an IP address, the *Management Interface Board* supports several methods of control:

- SNMP – Simple Network Management Protocol (SNMP v1)
- TELNET
- HTTP Web Based Interface

The Management Interface Board also supports up to 16 user accounts, although this functionality is not required as the JAS provides user authentication.

The Masterswitch control for the APT was originally done using TELNET. This has been rewritten as part of this thesis to use the SNMP protocol, covered in detail in Chapter 4.

2.8 Web cameras

There are currently three web cameras installed at the site, detailed information on each camera is shown below. The video output from each camera is connected to an *AXIS 240 Web camera Server* which provides control and image retrieval facilities via an HTTP interface.

Java code, developed by Michael Ashley provides an interface to the web camera server. This code has been integrated into the Client GUI application, covered in Chapter 5.

2.8.1 Panasonic "fish eye" black and white camera.

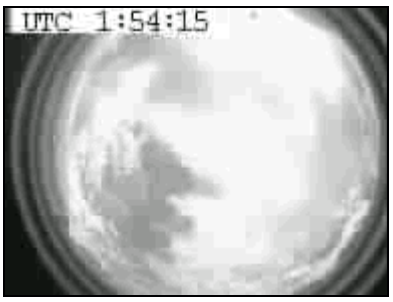


Figure 2-10 Sky camera image

This image was taken on a particularly cloudy day. Potentially, software could determine weather conditions using images from this camera.

A 2GHz transmitter/receiver is used to transmit video information to the web camera server to prevent lightning damage.

2.8.2 *Sony* colour telescope camera

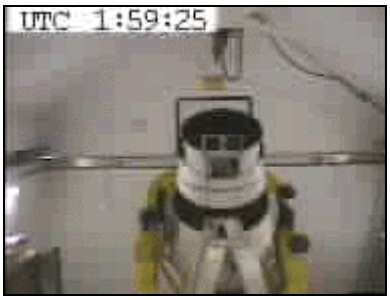


Figure 2-11 Telescope Image

Here we can see the telescope in its parked position. Notice the section of the roof cut out behind the telescope to allow the roof to clear the telescope.

This camera is mounted on a Pan, Tilt, and Zoom stage which allows it to be directed anywhere within the enclosure.

2.8.3 *Watec* black and white infrared camera.

Figure 2-12 Infrared camera image

The infrared camera's field of view cannot be altered. Although this image was taken during the day, a similar image is obtained at night when used in conjunction with the Infrared lamp.

2.9 Controller Area Network (CAN)

Controller Area Network (CAN) is a serial bus system especially suited to interconnect smart devices to build smart systems or sub-systems (2). A CAN is a collection of nodes, where each node can support digital I/O and analogue lines.

Originally designed for the automotive industry, CANs are used in a broad range of industries such as factory automation, machine control, building automation, maritime, medical and railway applications.

The CAN protocol boasts a sophisticated error detection mechanism which makes it ideal for the APT environment where reliability is a primary concern. Although all CAN nodes can transmit instructions, a feature to facilitate redundancy. The CAN at the APT is controlled by a single PCI CAN adaptor[i].

Currently CAN nodes are installed to control the roof circuitry, the observatory lights, and a switchboard of 240V outlets. (as shown in Figure 2-14).Much of the work done to install the APT CAN system has been documented in (52).

2.10 Roof

The sliding Roof, clearly visible in Figure 2-1 and Figure 5-5, is one of the more crucial systems. Failure to close the roof in foul weather (or in bright sunlight) could result in significant damage to the telescope and other equipment within the enclosure. Every effort must be made to ensure this veritable catastrophe must never occur.

The roof circuitry, discussed in (52), ensures that several safety conditions must be met before the software will attempt to drive the roof motors.

- Telescope must be in the correct position
- Roof *Emergency Stop* button, located on the roof control box, must be depressed
- The Crane system must be stowed
- Crane power off
- Correct roof position information (Roof Closed, Roof Open Sensors)

[i] JANZ VMOD-ICAN3 PCI CAN Adaptor, interfaced using /dev/can

2.11 ROTSE

Figure 2-13 Nearby ROTSE Enclosure

The ROTSE (Robotic Optical Transient Search Experiment) enclosure is situated just a few metres from the APT building. The ROTSE Telescope, like the APT has a wide field of view (1.8 x 1.8 degrees) and is equipped with a very fast slewing mounting. This makes it ideal for tracking Gamma Ray Bursts, as discussed in Appendix E.3. When it is fully operational , ROTSE will share much of the hardware and infrastructure of the APT system.

Currently installed in the ROTSE enclosure is a PC[i] used to provide weather information, the telescope itself was expected to arrive in early October 2002. However, at the time of writing ROTSE is still being prepared for shipment at Los Alames National Laboratory, New Mexico.

[i] moody.anu.edu.au, 486 50MHz, 32MB, 512MB HDD, running Redhat 7.2 Linux

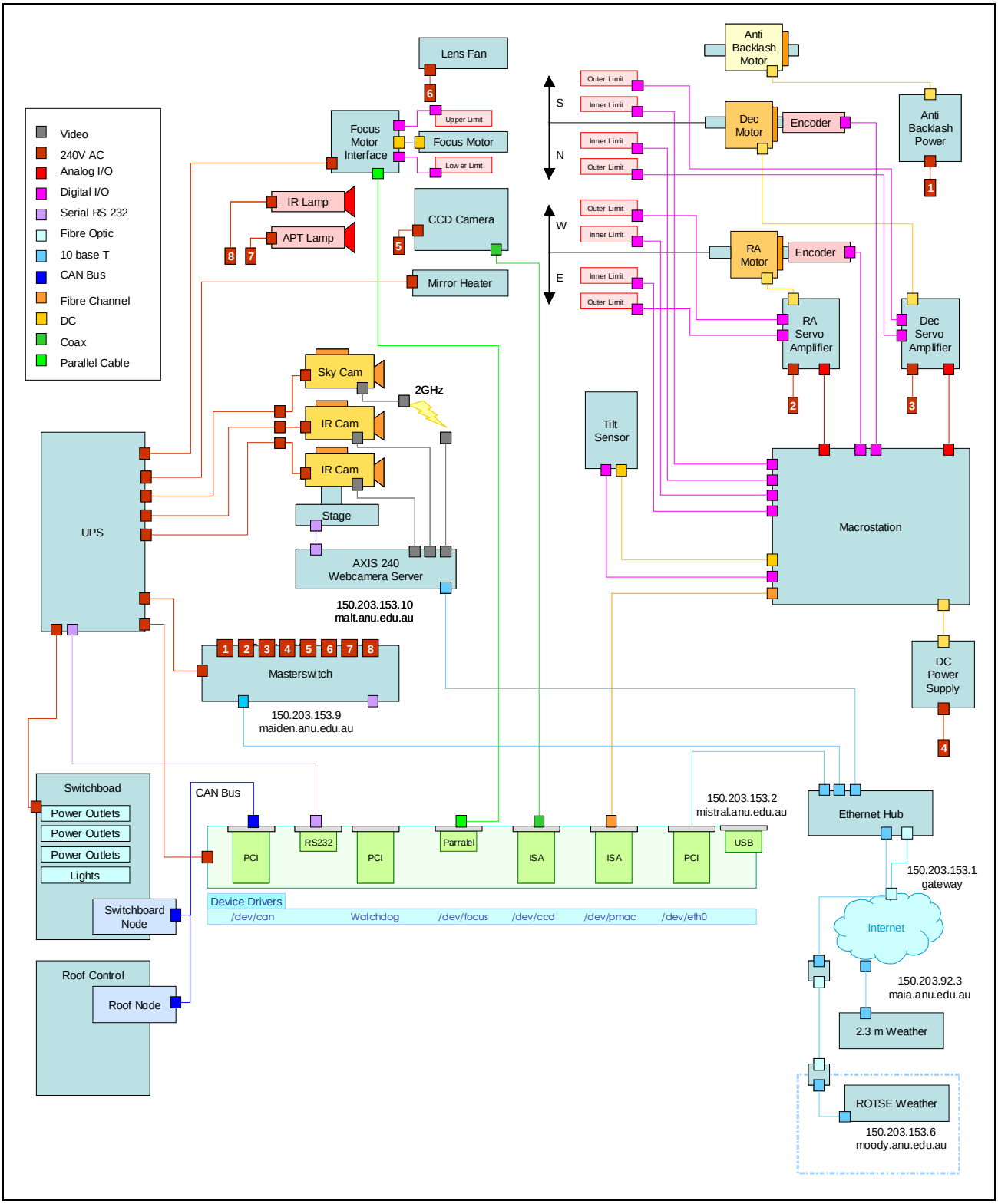


Figure 2-14 APT architectural diagram

3 APT software

3.1 Introduction

As stated in 2.3, the GNU Linux operating system is an integral part of the APT system. It provides a centralised platform for the APT control software. Fundamental services such as the file system, networking and device drivers provide the basis for control software to be built.

3.2 Portable Telescope Control System (PTCS)

PTCS is a generic telescope control system designed to support multiple telescopes in multiple operating environments. It was written by Jeremy Bailey for the AAO[i] in an attempt to promote reuse of a collection of well known and trusted algorithms for pointing and tracking a telescope. PTCS is implemented in the DRAMA software environment and consists of a set of DRAMA *tasks*.

PTCS is currently used at two telescopes, the APT and the 15m James Clerk Maxwell submillimeter Telescope (JCMT) on Mauna Kea, Hawaii.

Currently the JAS server interfaces to PTCS via a Java interface to DRAMA.

3.2.1 DRAMA

The DRAMA system is a portable environment designed for writing distributed instrumentation software (14). Developed by the AAO, it is essentially a platform independent system of interprocess communication. *Messages* are sent and received between DRAMA *Tasks.*

3.2.2 THI

The *Telescope Hardware Interface*, like PTCS is also a DRAMA *task*. It serves to abstract the specific architecture of the telescope control hardware. The THI provides access to universal time (UT) information, sending of demand positions to the servos, and reading the encoder values for each axis.

The APT implementation of the THI interfaces to the PMAC device driver, which in turn provides access to servo drives and encoders. UT information is calculated from values obtained from the PC system clock[ii].

[i] Anglo-Australian Observatory

[ii] Accuracy of the system clock is maintained by `ntpd`, the network time protocol daemon

3.3 Command line tools

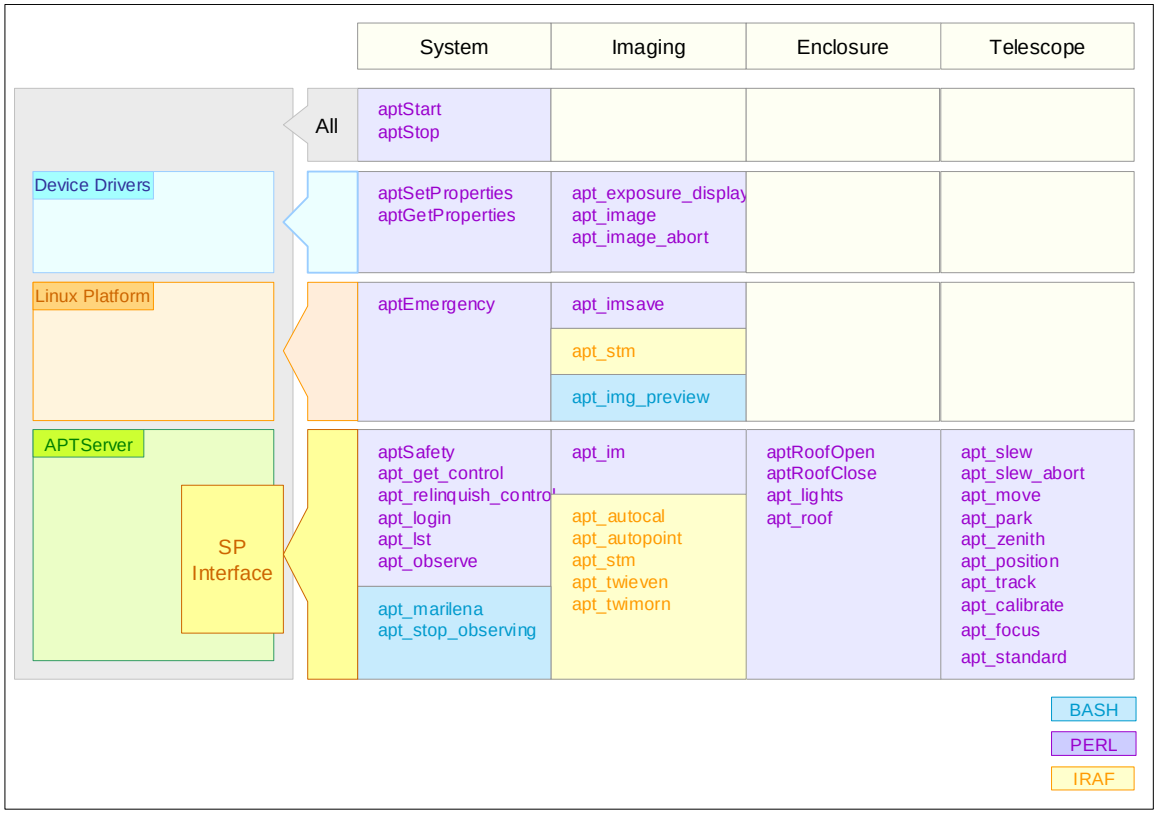


Figure 3-1 Mistral APT Command Line Tools

3.3.1 Scripts

The diagram above shows all the APT command line tools according to their language and the layer in which they interface to the system. This diagram should only be used as a guide, in some cases, is it not entirely correct. For example, the aptSetProperties/aptGetProperties commands interface to many subsystems. These commands are configured for the *apt* user on mistral.

3.3.2 IRAF

The *Image Reduction and Analysis Facility* is a general purpose software system for the reduction and analysis of astronomical data. The IRAF distribution, which is freely available, can be obtained from (11). One of the more powerful features of the package is the *Command Language* (CL) scripting facility, a programming environment for scientific applications.

Many of the APT commands are implemented as IRAF CL scripts. See Figure 3-1. These scripts can make decisions based on the results of image analysis.

3.4 Java Automation System (JAS)

3.4.1 Introduction

The Java Automation System (JAS), developed by Keith Bannister in (52), was designed to provide multi-user, secure, distributed automation of the APT system.

In early 2002, the JAS was redesigned to improve its functionality and to further abstract its dependence on the JSDT package. The *Java Shared Data Toolkit* (JSDT), discussed in detail in (52), is essentially the middleware which facilitates network communication of the JAS. Unfortunately Sun[i] has ceased development and support of the JSDT in favour of JXTA. JXTA, or *Project Juxtapose*, is Sun's peer to peer solution for distributed computing. In light of this, it is desirable to implement an alternative JAS transport layer, based on JXTA, as discussed in Chapter 7.3.7.

The primary function of the JAS is to allow the remote execution of *Commands* and the distribution of data to multiple clients, whilst restricting control to authorised users.

3.4.2 Architecture

The basic operation of the JAS system is presented in Figure 3-2, shown below.

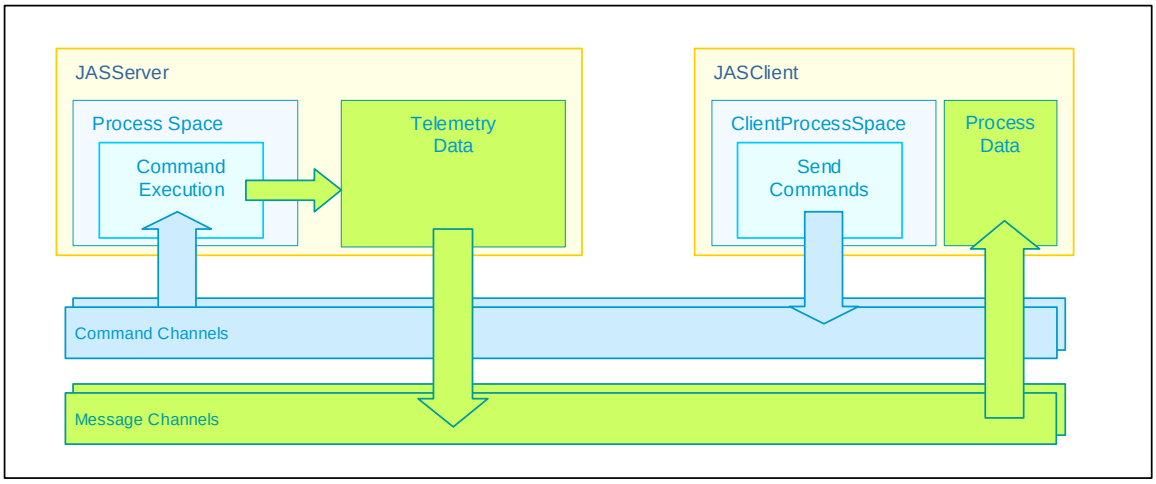


Figure 3-2 JAS Communication Diagram

3.4.2.1 JASChannels

All data transfer within the JAS system is achieved using *Channels.* A *Channel* is analogous to a blackboard. *Messages* are written to the Blackboard/Channel such that all clients can read/receive this message.

```
public void sendToAll(JASMessage message){ ... }
```

Note that Messages can also be sent to specific clients:

[i] Sun Microsystems

```
public void sendToOthers(JASMessage message) { ... }
public void sendToClient(JASMessage message, String clientName) { ... }
```

`JASMessages` can contain any **`serializable`** Java `Object`. Telemetry information is typically sent as a Java `Map` object within a `JASMessage`.

3.4.2.2 Command execution

In many ways the command execution environment of the JAS is similar to that of an operating system. Any object implementing the `Command` interface can be executed by a `Process` within a `ProcessSpace`. Process objects can `execute()`, `abort()`, and `signal(Object arg)`. Each `ProcessSpace` is assigned a `ProcessManager`. The `ProcessManager` interface is designed to be implemented by the JAS Application, it is responsible for deciding whether an operation on a `Command` is allowed. For example, the APT implements a `PriorityExclusiveManager` to ensure that only one authorised user can execute commands and thus *have control.*

To facilitate remote command execution, a `ProcessSpace` is bound to a `Channel`, by a `ServerTransport` object. This allows other `JASClients` joined to this `Channel` to send the `JASServer` commands via a `ClientProcessSpace`.

3.4.3 SP interface

The *Serial Protocol* (SP), also developed by Keith Bannister and discussed in (52) is essentially a socket based method of communication provided to allow any tool to interface to the APT-JAS System. Most of the APT command line tools use the SP interface to communicate with the JAS server. This is shown in Figure 3-1.

3.5 APT server

The APT Server is an application interfacing the hardware to the JAS to enable distributed control. These hardware abstractions are used to construct `APTCommands` and send telemetry data to JAS Clients.

- `apt.roof` provides control of the sliding roof via the JCAN interface.
- `apt.ptcs` is a DRAMA client to the PTCS system discussed in 3.2.
- `apt.park` provides routines to *park* the telescope in common positions. i.e Zenith, Roof Movement etc
- `apt.masterswitch` uses the SNMP protocol to control the Masterswitch (discussed in detail in Chapter 4).
- `apt.image` Allows control of the CCD through the APT System framework (3.5.1)

3.5.1 APTSystem framework

The `apt.system` package was designed to interface several systems to the JAS, not under Java control[i], to enable remote control and distribution of data. It is essentially a wrapper of the `aptGetProperties` and `aptSetProperties` scripts which abstract the implementation of these

[i] Such as 2.3m weather, UPS, Network and PC status information.

subsystems as a set of key-value properties. The Masterswitch, discussed in detail in Chapter 4, is controlled in this way.

4 APT Masterswitch implementation

4.1 Introduction

Currently the Masterswitch is controlled via an "Expect" script which runs a telnet session to interface to the device. *Expect* is a scripting language designed to respond to text on the screen.

The JAS interfaces to the Masterswitch using the APTSystem framework. Each time a Masterswitch outlet property is *set*, the APTSystem calls the `aptSetProperties` script which in-turn invokes the expect script. Eventually resulting in the outlet changing state. I.e. Switch on or off.

There are several issues with the current implementation:

- There is no state change notification
  The Masterswitch device must be queried at regular intervals in order to discover when an outlets state has changed, possibly due to another user controlling the device.
- Unreliable, occasionally the TELNET session created within the expect script fails for unknown reasons.
- Poor Error handling. If the script fails, very little error information can be obtained.

The SNMP (Simple Network Management Protocol) interface provides a much more powerful way to control the hardware. When the SNMP interface is enabled, the Masterswitch generates SNMP Traps which can be used to notify the system of any state changes within the system. Capturing this information at runtime allows notification of state changes within the system rather than using a polling technique.

It is desirable for the APT System to be able to access the Masterswitch as a Java Object. This will allow more powerful `JASCommands` to be written, which will, in turn provide a framework for a more reliable and flexible software module.

4.2 Controlling the masterswitch

Due to the simple functionality of the Masterswitch, the requirements for controlling it are fairly straightforward. These are:

- get and set outlet state

- Real-time notification of outlet state changes
  It is vital that the system always reflects the current state of the Masterswitch. Although the outlets are unlikely to be switched often, correctly knowing the state of each outlet at all times would be valuable information, particularly if a fault had occurred elsewhere in the system.

- Error Notification
  Internal errors and warning conditions within the Masterswitch should be able to be monitored

- Support for adding multiple Masterswitch devices in the future.

These requirements were translated into the Java interfaces shown below:

```
// Java interface to the APC AP9212 Masterswitch
public interface Masterswitch {

 // Outlet States
 public static final String OUTLET_ON                = "On";
 public static final String OUTLET_OFF               = "Off";
 public static final String OUTLET_REBOOT            = "Reboot";
 public static final String OUTLET_UNKNOWN           = "Unknown";
 public static final String OUTLET_ON_WITH_DELAY     = "On with delay";
 public static final String OUTLET_OFF_WITH_DELAY    = "Off with delay";
 public static final String OUTLET_REBOOT_WITH_DELAY = "Reboot with delay";

 public String setOutletState(int outlet,String outletState)
                     throws MasterswitchException;
 public String getOutletState(int outlet)
                     throws MasterswitchException;
 ...


 // Event Notification
 public void addMasterswitchListener( MasterswitchListener listener);
 public void removeMasterswitchListener( MasterswitchListener listener );

}
```

Figure 4-1 Masterswitch interface

```
// Event Notification
public interface MasterswitchListener {
    public void outletStateChanged(int outlet, String newState);
    public void outletNameChanged (int outlet, String newName );

    // Something has changed, but we are not sure what
    public void stateChanged();

}
```

Figure 4-2 Masterswitch interface

4.3 Code

4.3.1 SNMP libraries

In an effort to reduce development time and increase reliability, the decision was made to use a 3rd party SNMP package. Several Java SNMP implementations exist:

Open Source

- JSNMP[i]
- Westhawk SNMP Stack (20)
- AgentAPI (22)
- JawaOpenEyes (Network Monitoring Tool) (23)

Commercial

- Advent Net (24)

[i] A sub-project of OpenNMS (21)

The *AdventNet* package is clearly of the highest quality. Feature rich, and backed by comprehensive documentation. However, the Masterswitch SNMP implementation will only require a basic set of SNMP operations, all supported by the open source packages.

Of the open source alternatives, the JSNMP package was chosen primarily for its superior documentation, support and activity within the SNMP community. Also, the AgentAPI is used to parse the APC PowerNet MIB, (28).

A brief overview of the SNMP protocol is given in Appendix D.

4.3.2 Configuration

- Enable SNMP on the Masterswitch

  This is achieved though the HTTP interface to the APT Management Interface board. Mistral (150.203.153.2) is given read/write access and added to the list of hosts to send SNMP traps.

- Mistral's firewall settings must be configured to allow access to UDP ports 161,162. This is achieved using the `ipchains` Linux firewalling utility.

4.3.3 SNMP messages

Control of the Masterswitch outlets is achieved by GETs and SETs of the two OID's[i] shown below:

- **`sPDUOutletName`**
  String label for the Outlet (Max 20 characters)

- **`sPDUOutletCtl`**

```
outletOn              (1)
outletOff             (2)
outletReboot          (3)
outletUnknown         (4)
outletOnWithDelay     (5)
outletOffWithDelay    (6)
outletRebootWithDelay (7)
```

  Detailed documentation on the outlet behaviour for each of these values is documented in (27) and (28), and available through the `apt.masterswitch` API JavaDocs.

Figure 4-3 Masterswitch OIDs

On initialisation, the POWERNET.MIB (28) is parsed and loaded into memory using the AgentAPI. The OIDs shown in Figure 4-3 must be converted to a String of `.' delimited integers denoting their location in the MIB tree before they can be inserted into a PDU[ii]. This value is obtained by calling `mibModule.getNode("sPDUOutletName").getOID().toJavaValue()`.

For example, the OID **`sPDUOutletName`** is equivalent `to:`

`".iso.org.dod.internet.private.enterprises.apc.products.hardware.masterswitch.sPDUOutletConfig.sPDUOutletConfigTable.sPDUOutletConfigEntry.sPDUOutletName"`

[i] Object Identifiers, see Appendix D, SNMP overview
[ii] Protocol Data Unit, see Appendix D, SNMP overview

which is represented internally as *".1.3.6.1.4.1.318.1.1.4.5.2.1.3"*.This string is then appended with *".<outlet-number>"* to specify the outlet. The OID, and some data, if the operation is a *SET*, are packaged into a PDU which is then sent to the Masterswitch using the *JSNMP* `SnmpSession` object.

The SNMP agent on the Masterswitch interface board then performs the appropriate action, resulting in an SNMP response being returned. The response packet is processed, resulting in the executing thread returning to the caller.

4.3.4 Synchronisation

The `SNMPMasterswitch` is a multithreaded object. Calls to Masterswitch methods are blocked and queued implicitly by Java `synchronization`. The blocked threads are then woken by either a timeout or an SNMP response message from the device.

4.3.5 Event notification

There are two alternative methods used to notify `MasterswitchListeners` of any state changes:

- Responding to SNMP Traps

  The Masterswitch generates SNMP traps for numerous events. These traps can be decoded to discover events that have occurred on the Masterswitch. A complete specification of Masterswitch traps is provided in (27) and (28). `Root` permissions are required by the `SNMPTrapDaemon` to bind itself to UDP port 162. This method is more efficient and also provides more accurate error information.

- Polling

  A `TimerTask` periodically queries the state of the Masterswitch and compares the new information with cached values. A Masterswitch event is triggered if a change is detected.

Upon initialisation, the `SNMPMasterswitch` will attempt to listen to SNMP traps by starting the trap daemon. If this fails, a polling technique will be used, querying the Masterswitch every three seconds.

4.4 JAS integration

To allow portability, all code integrating the Masterswitch to the JAS is handled in the `JASMasterswitch` and `Command` Objects. Leaving the `apt.masterswitch` package an independent software module.

The `JASMasterswitch` object has several responsibilities:

- Initialise the SNMP implementation of the Masterswitch
- Send status information as JASStatusMessages to clients

- Provide initialised references to the Masterswitch Object to be used by *Commands* to interact with the hardware

4.4.1 Commands

Two commands were added to the APT Command set using the procedure defined in Appendix B.4. Given the simplicity of these commands, they only need to override the `execute()` method.

```
// Switch Outlet Command
public class MasterswitchSwitchOutletCommand() extends APTCommand{
  public MasterswitchSwitchOutletCommand(int outlet, String newState ) {...}
  ...
  public Object execute(Process parent) throws Exception {
    String returnVal = null;
    try {
      Masterswitch ms = JASMasterswitch.getMasterswitch();
      returnVal = ms.setOutletState(outlet, newState );
    } catch (MasterswitchException e) {
      logger.log( Level.INFO, "Masterswitch Command Failed" + e );
      e.printStackTrace();
    }
    return returnVal;
  }
}

// Rename Outlet Command
public class MasterswitchRenameOutletCommand() extends APTCommand {
  public MasterswitchRenameOutletCommand(int outlet, String newName ) {...}
  ...
  public Object execute(Process parent) throws Exception {
    String returnVal = null;
    try {
      Masterswitch ms = JASMasterswitch.getMasterswitch();
      returnVal = ms.setOutletName(outlet, newName );
    } catch (MasterswitchException e) {
      logger.log( Level.INFO, "Masterswitch Command Failed" + e );
      e.printStackTrace();
    }
    return returnVal;

  }

}
```

Figure 4-4 Masterswitch commands

The new commands are installed as *privileged*, as shown in Appendix B.4.2. This ensures that the Masterswitch commands may only be executed by the user who currently has control, i.e. the *privileged* user.

```
// APTServer.java
// Include the Masterswitch commands as privileged Commands
static final Class[] privCmds = {
     ...
     MasterswitchSwitchOutletCommand.class,
      MasterswitchRenameOutletCommand.class };
```

Figure 4-5 Masterswitch privileged commands

4.4.2 Messages

Masterswitch status information is broadcast to clients on the `CHANNEL_MASTERSWITCH`, initialised at the `APTServer` start-up .

```
...
// APTServer.java
// Create the Masterswitch Channel
JASChannel masterswitchChannel =
    client.makeChannel(Channels.CHANNEL_MASTERSWITCH);
masterswitchChannel.join();

// Initalise the Masterswitch
JASMasterswitch.getJASMasterswitch( masterswitchChannel );
...
```

Figure 4-6 Initialising the Masterswitch channel

The `MasteswitchChannelWatcher`, instantiated within the `JASMasterswitch` object, monitors the `JASChannel`, using the method discussed in Appendix B.5, to send full status information to new clients joining the Masterswitch channel.

```
// Monitor the Masterswitch Channel and send any new subscribers all status
// information
private class MasterswitchChannelWatcher extends ChannelAdaptor {
  public void channelConsumerAdded(ChannelEvent event) {
    try {
      log.log( Level.INFO, "Detected new "+ Channels.CHANNEL_MASTERSWITCH +
                           " subscriber: "+event.getClientName() );

      masterswitchChannel.sendToClient( prepareCompleteMsg(),
                                        event.getClientName()  );
    } catch (JSDTException e) {
      log.log( Level.INFO, "Couldn't send new subscriber information");
    }
  }
}
```

Figure 4-7 Masterswitch channel monitoring

To keep the status information up to date, the `JASMasterswitch` must broadcast `JASMessages` notifying clients of any *change* in state. This is achieved by utilising the `MasterswitchListener` interface.

Whenever a *Masterswitch Event* occurs, the `JASMasterswitch` prepares and sends a `JASStatusMessage` with the updated state information. The *key* values used to identify properties within the `JASStatusMessage` are statically defined in `JASMasterswitch.java`, as shown below in Figure 4-8.

```
public static final String KEY_OUTLET_1_STATE = "Outlet 1";
...
public static final String KEY_OUTLET_8_STATE = "Outlet 8";
...
// MasterswitchListener methods
public void outletStateChanged(int outlet, String newState) {
...
  // Send a JASStatusMessage containing the new information to all clients
  // on the masterswitch channel
  JASStatusMessage msg = new JASStatusMessage();
  Map map = msg.getValueMap();
  map.clear();
  map.put( keyForOutletState(outlet) , newState);
  try {
    masterswitchChannel.sendToAll( msg );
  } catch (JSDTException e) {
    log.log(Level.WARNING, "Failed to notify clients of Masterswitch state change",e);
  }
}
```

Figure 4-8 Masterswitch message broadcasting

4.4.3 SP modifications

The `APTSPClient` will need to be modified to automatically join the `CHANNEL_MASTERSWITCH` and enable SP clients to retrieve Masterswitch status. This is not currently implemented. A revised apt_masterswitch command is proposed in Chapter 7.3.9.

4.5 Screenshots

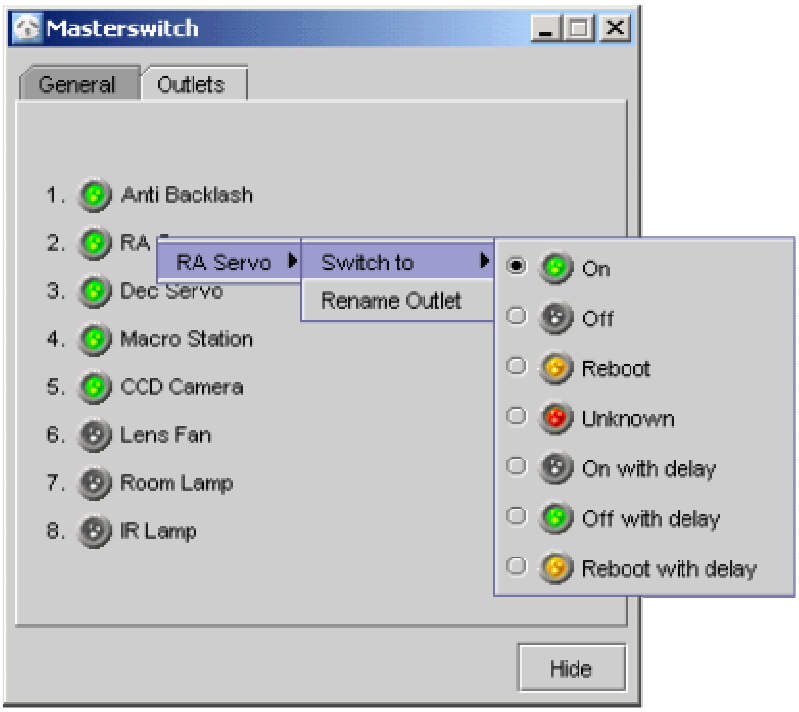


Figure 4-9 Masterswitch user interface

4.6 Conclusion

The design proposed and developed is being successfully used in the live system, providing a more reliable fine grained control of the hardware. SNMP Trap messages are also logged which may provide very useful information in the event of a serious hardware failure or devices in the enclosure.

5 APT user interface implementation

5.1 Introduction

The existing user interface (shown below), was originally developed by Keith Bannister to provide an interface to the APT demonstrating the use of the JAS system. Since it was produced, the JAS System has matured and many features have been added. A higher quality user interface needs to be developed to fully utilise the remote operation capabilities of the APT. This new interface aims to be more intuitive, responsive and functional than its predecessor.

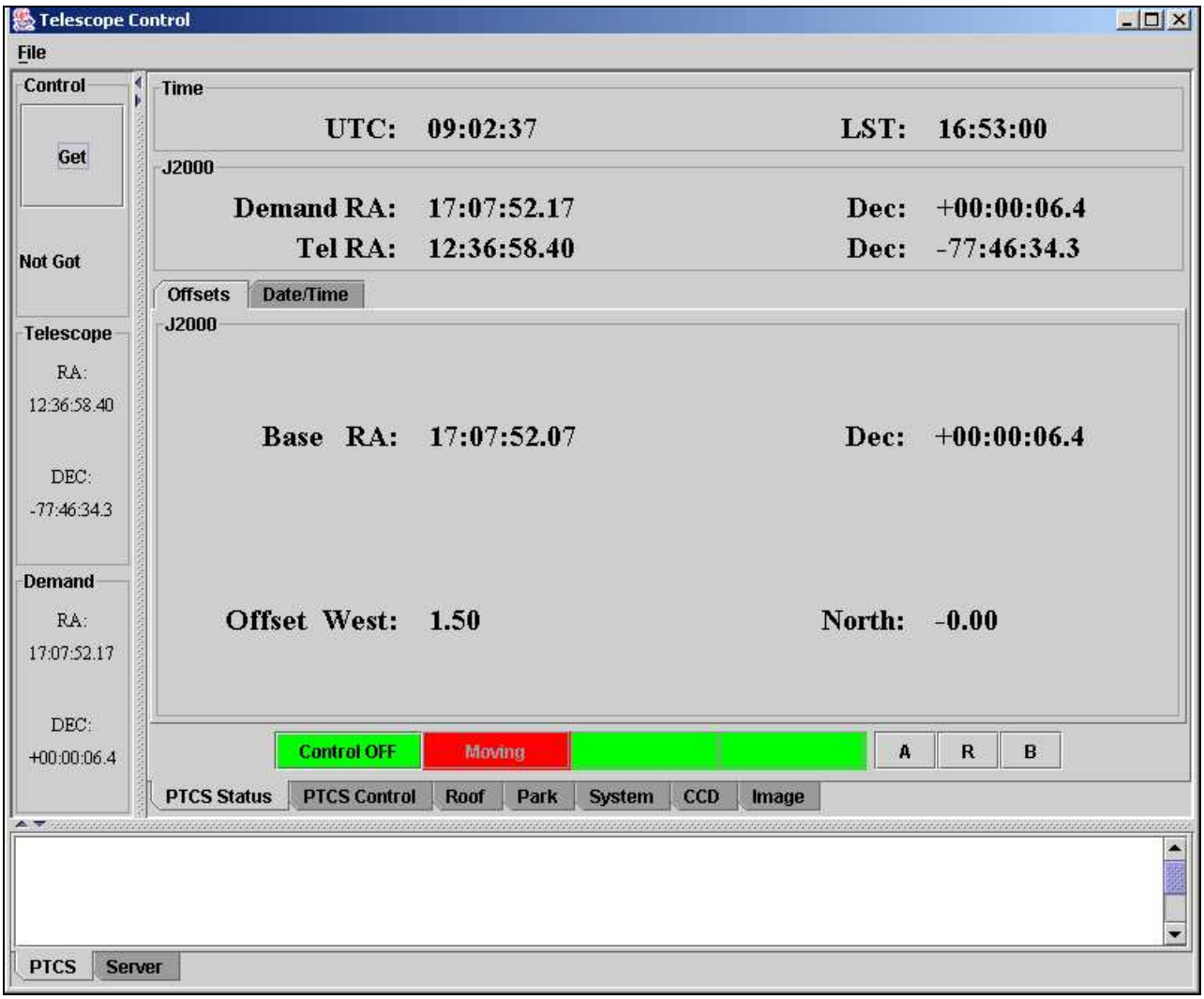


Figure 5-1 Existing user interface

5.2 Architecture

The user interface has been isolated as much as possible from the JAS to ease its portability to future versions of the JAS, or even other distributed control systems. Although many components reference JAS interfaces and objects, most JAS routines are found in the `JASComms` class.

The diagram below shows the flow of data throughout the system.

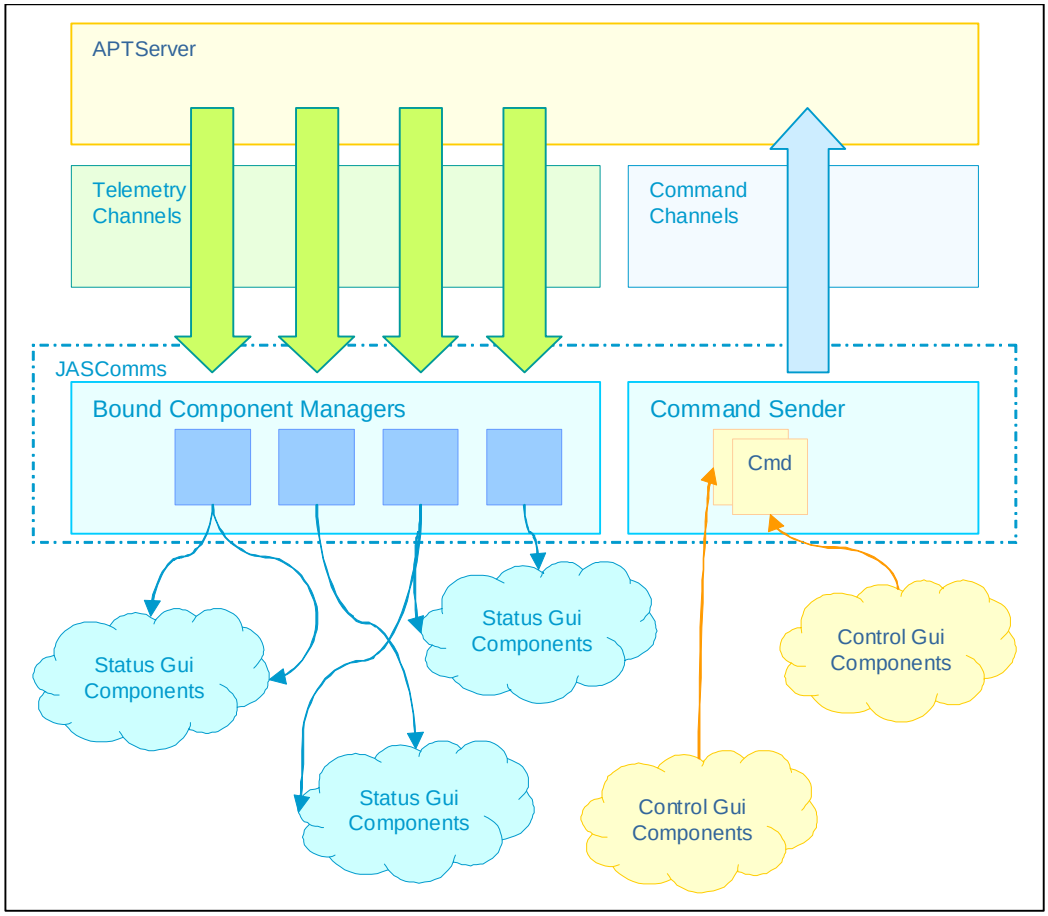


Figure 5-2 Client GUI architecture

5.3 Process manager

This panel is a graphical representation of the JAS `ProcessListener` interface, displaying JAS `ProcessEvents` as they arrive from a `ClientProcessSpace`. Each process is assigned a row in the table displaying its status information, as shown in Figure 5-3.

Currently, only the *privileged* process space is used. *System* and *general* commands may also be running within the JAS system in their respective process spaces.

Unfortunately this panel will only ever be able to show status information for commands sent by the user whilst they have control. This is a limitation of the JAS architecture. It would be more convenient to be able to show information on all commands running in the system at any one

time. This way, any connected users would be able to discern exactly what the system was doing, an invaluable tool for debugging and monitoring.

A solution, suggested by Keith Bannister, would be to create a `JASMessageSender` (see Appendix B.2) as a registered `ProcessListener` on the server side, to broadcast `ProcessEvents` as `JASMessages` to clients. Thus allowing all connected users to monitor JAS processes.

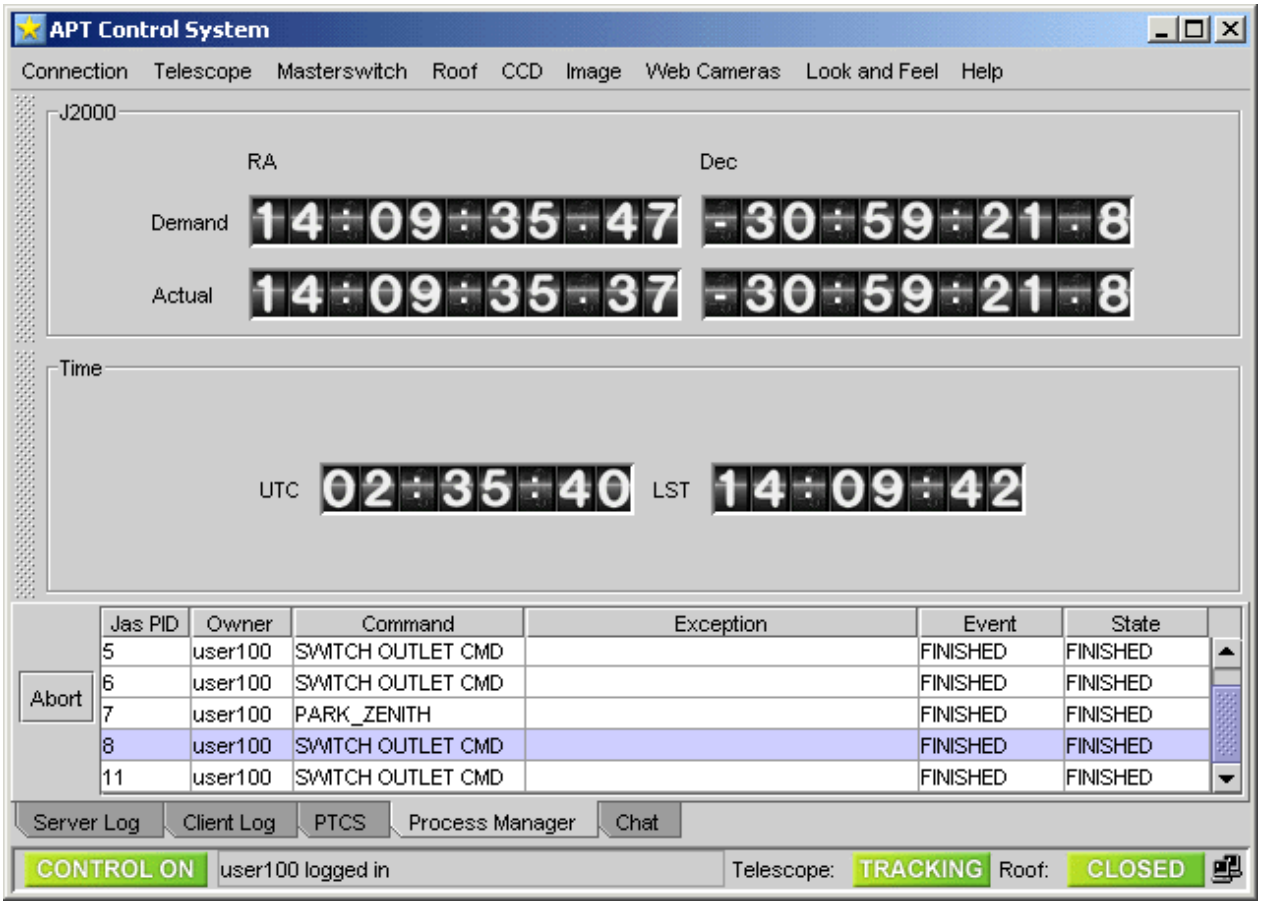


Figure 5-3 Process manager

5.4 Roof

For users unfamiliar with the APT System, the operation of the Roof should seem trivial. Behind the scenes there are many complications and issues with its operation due to the complexity of the control system and the large number of safety considerations. This complexity has been abstracted by the apt.modules.roof control software, designed and developed in (52). As a result of this, the state of the roof can be interpreted as a combination of the following variables:

- `MAN_AUTO:` This represents the state of the Manual / Auto switch on the side of the Control box at the APT Site. This must be set to *`AUTO`* for the software to operate. Possible values are *`UNKNOWN`*, *`MANUAL`*, *`AUTO`*
- `EMERG:` This is the roof emergency stop button on the same box. The roof will not function if this button is set. Possible values are *`OK`* and *`EMERG`*
- `POS:` The current position of the roof. Possible values are *`OPEN`*, *`CLOSED`*, *`MIDDLE`*, *`UNKNOWN`*

- `POWER:` The status of the roofs power supply. It is either ***`ON`***, or ***`OFF`***
- `MOVING:` Possible values are ***`OPENING, CLOSING, STOPPED, UNKNOWN`***

These values are obtained by listening on the `ROOF` Channel, their values can be seen using the *Roof Properties Frame*, shown in Figure 5-5. The *MOVING* and *POS* are interpreted using the table in Figure 5-4 to create the roof status icon on the main status bar.

		MovingState			
		OPENING	CLOSING	STOPPED	UNKNOWN
RoofPosition	OPEN	OPENING...	CLOSING...	OPEN	UNKNOWN
	CLOSED	OPENING...	CLOSING...	CLOSED	UNKNOWN
	MIDDLE	OPENING...	CLOSING...	WARNING	UNKNOWN
	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN

Figure 5-4 Roof Status Indicator Truth Table

The sole purpose of the *unknown* icon is to prompt the user to consult the *Roof Properties* frame, shown Figure 5-5, to obtain more accurate information about the roof state. Portions of this frame were adapted from the original `PtcsUi` GUI.

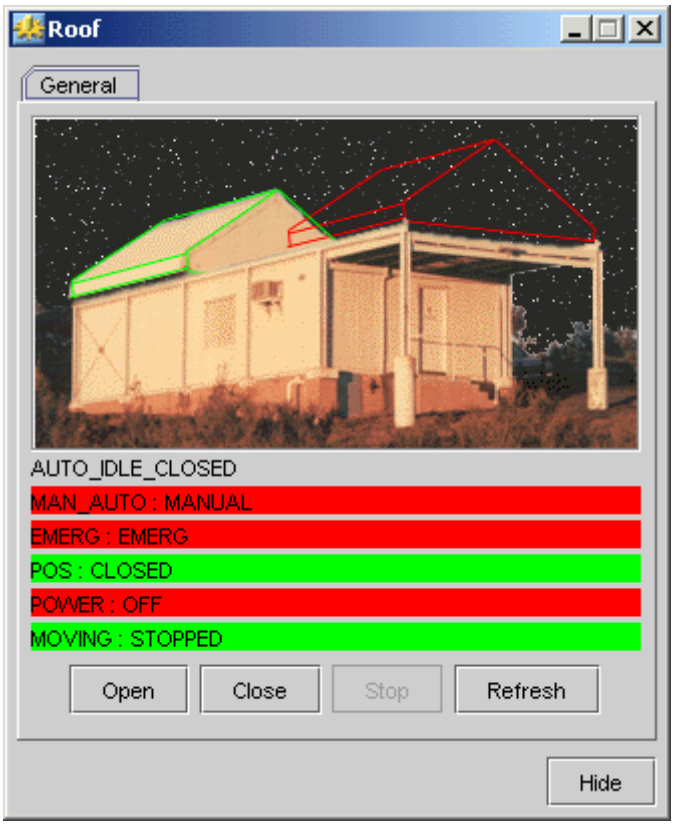


Figure 5-5 Roof properties frame

5.5 Chat system

Given the distributed nature and complexity of the APT control system it is desirable to be able to communicate with other users currently logged in. For example, a higher priority user would be able to ask the current user what they were working on before overriding their control.

This level of communication would also be very useful in a classroom environment. Students would be communicate remotely with other users controlling the telescope. For example, although the GUI can display a variety of status information, the intentions of the user in control could be somewhat difficult to discover. The chat system could be used to simply tell the connected users why the telescope is slewing to particular coordinates.

The APT chat system is most certainly this simplest of all the APT services, implemented as a `JASChannel` designed to send and receive `JASChatMessages`[i].

`JASChatMessages` are sent from a `ChatPanel` by simply utilising the `sendToAll()` method provided by the JAS, as shown below.

```
...
JASComms.getJASComms().getChatChannel().sendToAll(
    new JASChatMessage( System.getProperty("user.name")+": "+msg + "\n" )
);
...
```

Figure 5-6 Client sending JASChatMessages

When a `JASChatComponentManager` receives a `JASChatMessage` it conveys this information to any registered `JASChatComponents`, in accordance with the BoundComponent Framework discussed in Appendix B.3. Since the `ChatPanel` is a registered `JASChatComponent`, it receives this message and subsequently prints it to the screen, as shown in Figure 5-8.

The sole responsibility of the server is to initialise the `CHANNEL_CHAT` and create the `JASChatManager`.

```
...
// APTServer.java
// Initialise JASChatManager
JASChannel chatChannel = client.makeChannel( Channels.CHANNEL_CHAT );
chatChannel.join();
new JASChatManager( chatChannel );
...
```

Figure 5-7 JASChatManager usage

The `JASChatManager` simply creates a `ChannelMonitor`, as shown in Appendix B.5, which broadcasts notification messages when users *join* and *leave* the chat. *Joining* and *leaving* the chat is analogous to *joining* the *leaving* the chat channel.

[i] Currently implemented as a `String`

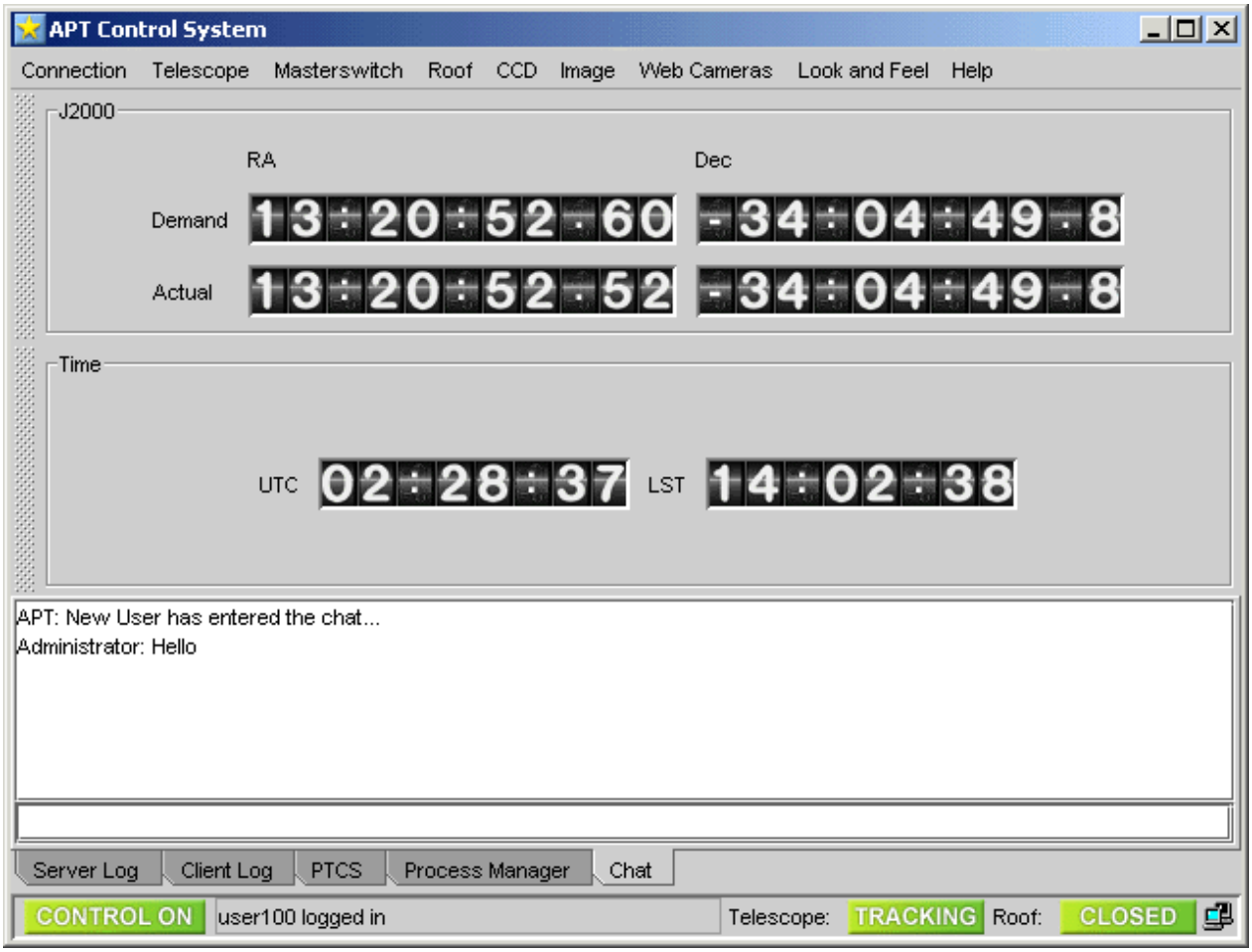


Figure 5-8 APT chat system

5.6 Look and Feel

The Java Language comes with a rich user interface toolkit, the *Java Foundation Classes,* also known as JFC-Swing. *Swing* provides a rich set of widgets [i] and class libraries to build a professional user interface. One of its key features is the pluggable look and feel framework. This allows the programmer to dynamically switch between any look and feel. A *Look and Feel* is a collection of widget styles, colours, fonts, and input device semantics.

Altering the look and feel servers two purposes. Firstly, for purely aesthetic reasons. Users of the software can choose a particular colour scheme or theme to suit their mood. Secondly, users familiar with the behaviour of a particular platform, such as MacOS or Windows, can configure the look and feel to emulate their environment. This level of customisation makes users more comfortable with the software.

APT Client GUI Application has been equipped with a *Look and Feel* menu which allows the user to switch the look and feel at any time.

5.6.1 Skinned Look and Feel

In addition to the *Look and Feel's* supplied with the JDK, many other vendors have implemented customised Look and Feels. Many of these can be found at the Javootoo website (34), which is designed as a primary reference for Look and Feel developers.

One of the more prominent customised Look and Feel's available is the *Skin Look and Feel* from L2FProd.com. A freely available Look and Feel supporting *Skins.* Skins use images and other techniques to drastically enhance the appearance of the GUI components.

Using the code idiom shown in Figure 5-9, the Skin Look and Feel was easily integrated into the APT Client Application.

```
/*  Skin Look and Feel Usage */
import com.l2fprod.gui.plaf.skin.SkinLookAndFeel;

  ...
  SkinLookAndFeel.setSkin(
      SkinLookAndFeel.loadThemePack(
           new URL("SkinPackFile.zip")
      )
  );
  SkinLookAndFeel.enable();
  updateComponents();
  ...

private void updateComponents() {
  SwingUtilities.updateComponentTreeUI( rootJFrame);
}
```

Figure 5-9 Skin Look and Feel usage

[i] A user-interface *control* such as a checkbox or drop-down list

5.6.2 Problems

- `SwingUtilities.updateComponentTreeUI()` in certain circumstances does not function as desired. For example, components that are not visible when this method is called will not be refreshed correctly and will retain the previous Look and Feel settings.

  This can be overcome by a more explicit and rigorous implementation of `updateComponents()`.

5.6.3 Screenshots

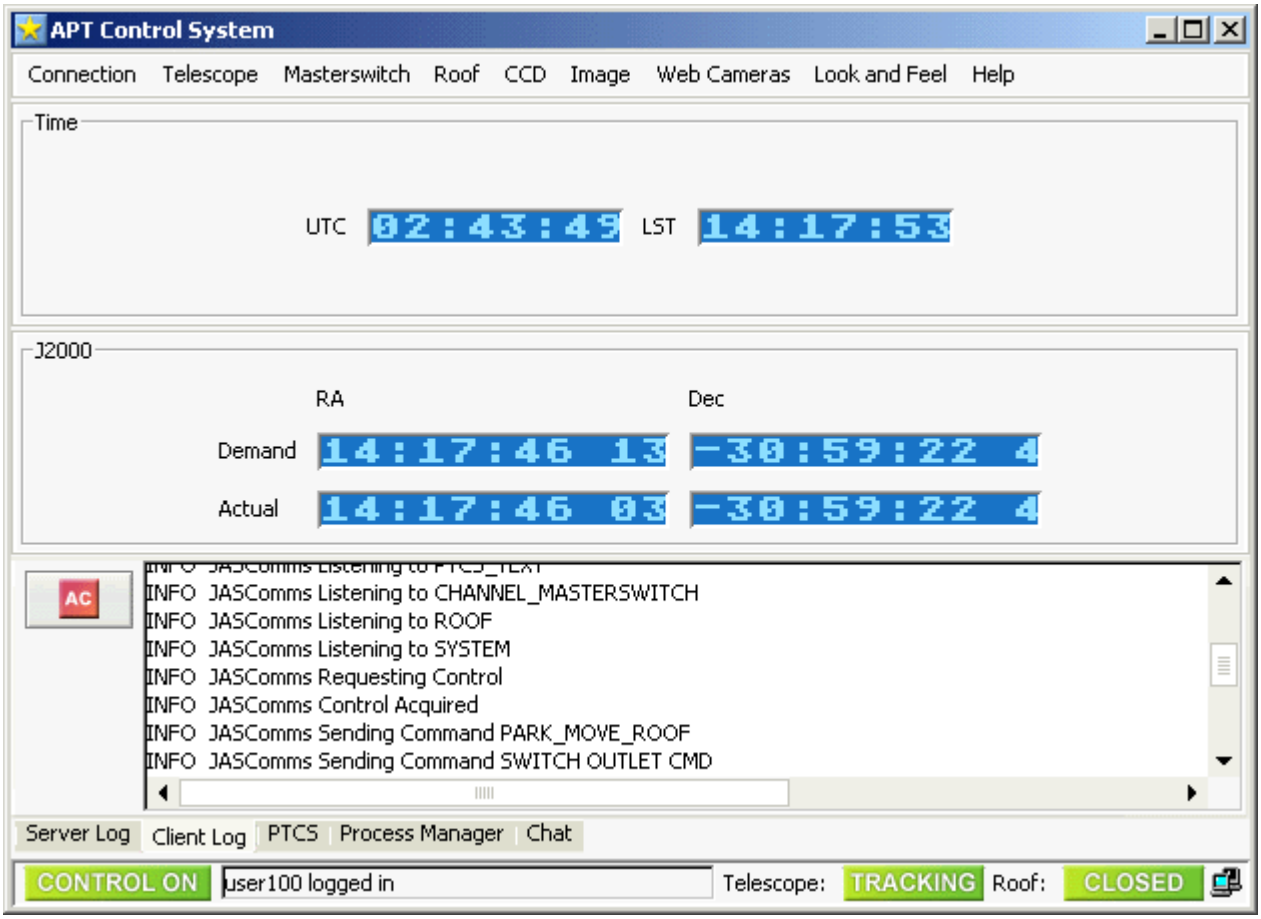


Figure 5-10 Main GUI with default *skin* Look and Feel and *Atari* textSkin

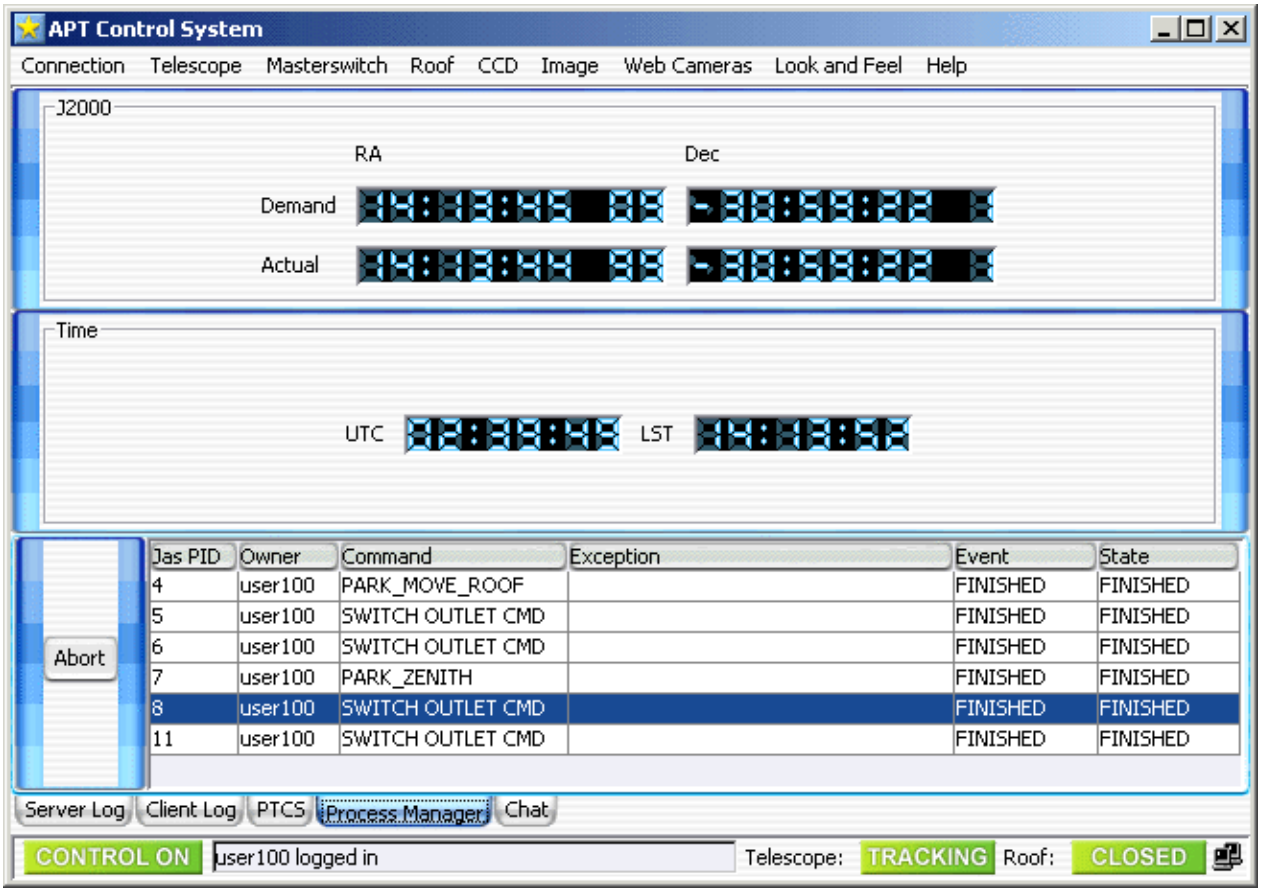


Figure 5-11 *Aqua* Look and Feel with *Blue Digits* textSkin

5.7 Conclusion

This GUI is significantly more attractive, responsive and easier to use than its predecessor, providing a clear representation of the APT system and its components. Although very little additional functionality has been implemented, the framework exists to do so. As a finer grained level of control is provided by the JAS, the GUI can evolve to support these enhancements.

Further improvements to the Client application are discussed in Chapter 7.

6 APT software deployment

6.1 Introduction

The APT software is a very complex system of integrated software components and is constantly under development. The Java APT source code alone is approximately 8000 lines across 300 source files. The system also depends on several external packages such as the JAS and JSDT.

Unfortunately, there is no test platform[i] and consequently the system spends the majority of its time running a test version of the software. Although thorough testing is important, it is crucial to preserve the ability to run an older (release) version of the software known to run properly.

Such a large and unique system requires code management tools to allow for more efficient development. To summarise, the APT software deployment system must satisfy the following requirements:

- Allow multiple developers to work on the code simultaneously.
- Compile and deploy multiple versions of the software in an efficient manner.
- Roll back to previous *trusted* versions when more reliable operation is required. i.e. Observing.
- Distribute client code to potentially large and diverse user bases. Eg, Classroom environment, professional astronomers.
- Guarantee that all clients are running the correct, compatible version of the code.
- Adapt to future changes to the structure of the application. For example, the introduction of additional libraries.

6.2 Version control

Since the development of the JAS and the APTServer, the entire code base has been managed within a CVS[ii] repository. CVS is the de facto industry standard version control system, rivalling commercial products such as Microsoft Visual SourceSafe and Rational Clearcase. CVS fundamentally allows multiple users access to the source tree, as well as maintaining a history of all changes made to each file. CVS also supports binary files, such as libraries, allowing the entire programming workspace to be stored in the repository.

Installation instructions for using CVS with the APT source code are included in Appendix C.

6.3 JNLP & Java Web Start

Java Web Start is Sun's reference implementation of JNLP[iii]. The Java Network Launch Protocol (47) is a specification published by Sun designed to streamline the deployment of Java applications over the Internet. It is used to manage and distribute the APT Client applications to all users.

---

[i] The JAS test harness developed by Keith Bannister has not been updated to use JAS2

[ii] Concurrent Versions System

[iii] Java Network Launch Protocol

Web Start is designed to address several of the problems traditionally associated with the deployment of standalone applications:

- Installation Issues
- Upgrading to the latest version
- Different versions of the JVM

Once Web Start (or any JNLP client) is configured on the users machine, any Web Start application can be downloaded, installed, and executed from a single click on a web page.

A JNLP enabled application is specified by an xml configuration file labelled `<app-name>.jnlp`. This file contains all the information required to setup and run the application such as jar file resources, properties, and main class information. The APT jnlp configuration files can be found in Appendix F.2.1 and F.2.2.

JAR files (Java ARchive) are similar to *tar*, or *zip* files. They are a collection of all the files required by the application, including class files, images, and other resources. Adding a `jar` file to the `CLASSPATH` variable is equivalent to adding the root directory of the extracted `jar`.

There are several third party implementations of JNLP such as NetX (part of the Object Component Desktop project[i]) and OpenJNLP (openjnlp.nanode.org) both striving to provide a richer implementation of JNLP than Web Start. However, both these implementations are still very much in a beta stage only partially implementing the JNLP specification.

6.3.1 Versioning

JNLP supports versioning of resource jar files in two ways. Either a `versions.xml` file to be used in conjunction with the `JnlpDownloadServlet` or simply naming the jar files according to the parsing grammar shown below in Figure 6-1.

```
file    ::= name __ options . ext
options ::= option ( __ options ) *
option  ::= V version-id |
            O os |
            A arch |
            L locale
```

Figure 6-1 JNLP VersionID parsing grammar

Jar file versions are specified using the file naming convention for several reasons. Firstly, the version of the jar files can be identified simply using a `dir` or `ls` command, a particularly useful feature in a UNIX environment where command line control is required. Also, the `versions.xml` file is yet another configuration file that must be maintained for the system to operate correctly. This added complexity is also the reason the `JnlpDownloadServlet` was not used in the first implementation of the APT deployment system. It is, however the obvious choice for improving the system to achieve faster and more efficient client download times.

Note that JNLP features such as *JARDiff*, designed to allow Web Start clients to only download the changes from one version of a jar to another, as opposed to downloading the entire new version, are only provided by the `JnlpDownloadServlet`.

[i] http://ocd.sourceforge.net

6.3.2 Security

By default, all Web Start applications are run in a restricted sandbox with the following limitations (sourced from (49)):

- No access to local disk.
- All jars must be downloaded from the same host. Note, however, that you can download extensions and JREs from any host as long as they are signed and trusted.
- Network connections are allowed only to host from which your jars were downloaded. ("Phone home restriction.")
- No security manager can be installed.
- No native libraries (not even in extensions).
- Limited access to system properties. (The application has read/write access to all system properties defined in the `.jnlp` file, as well as read-only access to the same set of properties as applets

The APT Client application, like many other standalone Java applications, requires unrestricted network access. This can be achieved by using the `<all-permissions/>` tag in the jnlp configuration file. When this security option is used, all jar files must be signed with a certificate. If the certificate is not *trusted* the user will be prompted with the dialog below warning them of the possible risks involved in running the application.

Security Warning
This application is requesting unrestricted access to your local machine and network.
Do you want to install and run: Ol's Skinned Text Field Demo
Signed and distributed by: Oliver Mather
Warning: Failed to verify the authenticity of this certificate. No assertions can be made of the origin or validity of the code.
It is highly recommended not to install and run this code.
Start
Details
Exit

Figure 6-2 Web Start warning dialog

A *trusted* certificate is one which can be verified as a trusted source. Trusted certificates are commercially available from companies such as Verisign[i] and Thawte[ii].

Many developers within the community have been requesting support for fine grained permissions in jnlp files[iii]. This would allow the above warning to be more specific, rather than simply requesting *unrestricted* access.

[i] http://www.verisign.com
[ii] http://www.thawte.com
[iii] http://developer.java.sun.com/developer/bugParade/bugs/4398087.html

6.3.3 Resource loading

Resources such as images, sounds, and any other additional application files cannot simply be referenced in the same way a normal application would. There are two major restrictions:

- All resources must be packaged in `jar` files. Primarily to support versioning and download management for JNLP clients.
- File paths cannot be used to reference the contents of these jar files. The JNLP specification does not stipulate *where* or in *what* form the applications are handled on the client side. Java Web Start, for example, renames downloaded jar files for caching purposes.

Consequently, the Web Start Developers Guide (45), provides the following construct to load resources. Note that the `getResource()` method returns a Java `URL` Object.

```
// Get current classloader
ClassLoader cl = this.getClass().getClassLoader();
// Create icons
Icon saveIcon  = new ImageIcon(cl.getResource("images/save.gif"));
Icon cutIcon   = new ImageIcon(cl.getResource("images/cut.gif"));
   ...
```

Figure 6-3 Suggested resource loading

Although this may seem a trivial modification to existing applications, complications can arise. For example, the `SkinnedTextField`, discussed in Chapter 8, requires a `ZipFile` object in the constructor of a `TextSkin`. The creation of a `ZipFile` from a `URL` is not a trivial operation. For this reason `TextSkin` packages must be downloaded and installed manually.

The free package *Rachel*[i], designed to simplify resource loading, is used in the APT Client application to load Skin Packages for the *Skinned Look and Feel*, discussed in 5.6.1.

6.4 Compilation

The Java based build tool *ant* is used to control compilation and deployment. Each CVS module is accompanied by a `build.xml` configuration file. This file specifies various *targets*, *tasks*, and *dependency* information required to compile and deploy the application.

The software deployment system can be seen in Figure 6-4. This diagram shows the usages of the different *ant* targets. Similar information is obtained using the `"ant usage"` target.

[i] http://rachel.sourceforge.net

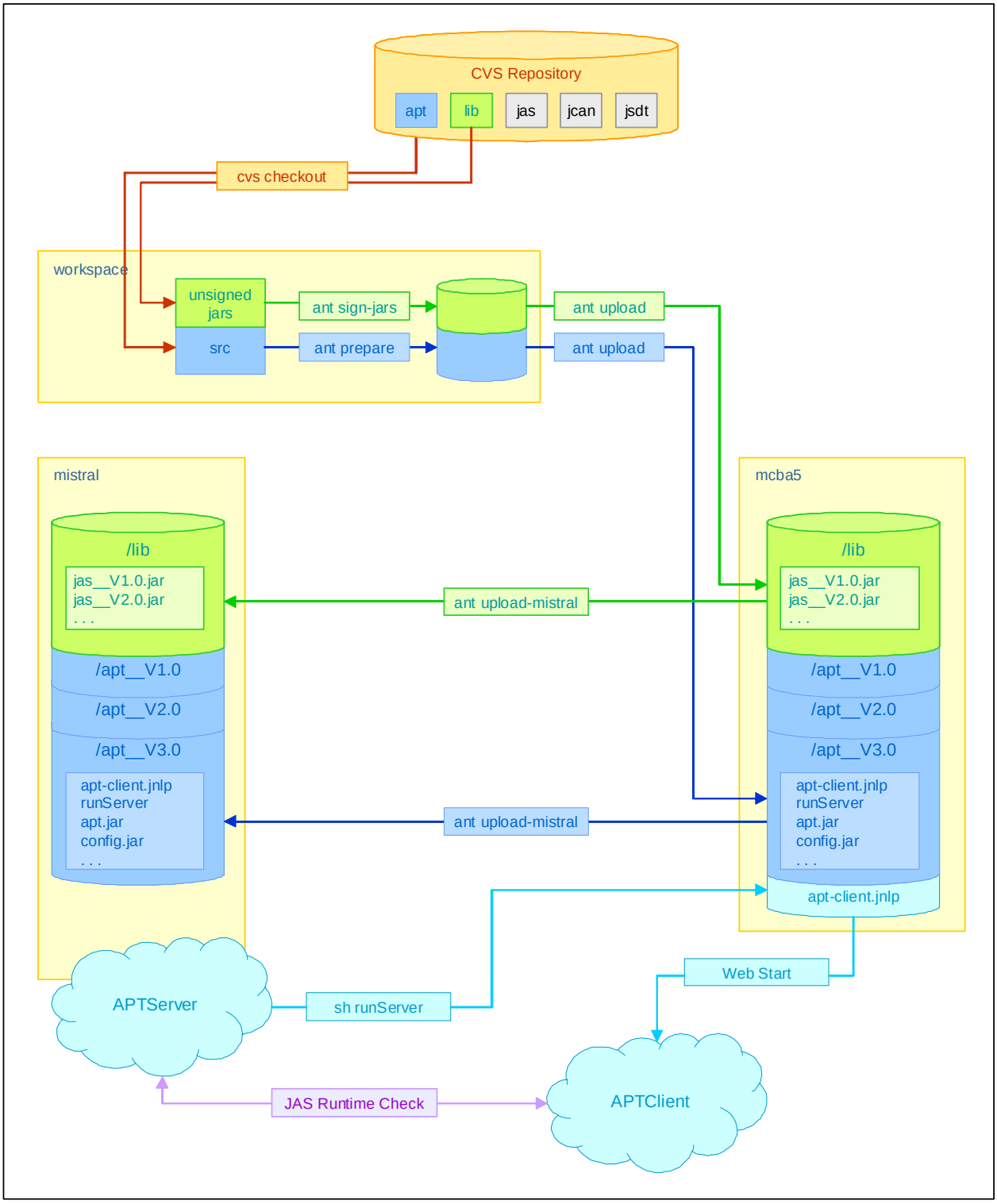


Figure 6-4 APT software deployment system

Once the workspace has been checked out from CVS the developer should manually edit the `build.xml (see Appendix F.2.3)` file and modify the *version-key* property. This property is used throughout the build process. This key must be unique, which is best achieved by simple incrementing the version count or perhaps using the developers name.

```
<property name="version-key" value="test-0.96"/>
```

Throughout the build process, covered below, a `dist/apt__V<version-key>` directory is created. This is where all the files belonging to the current version such as run scripts and configuration files are created. Any changes, such as adding or removing files must be reflected in modifications to the `build.xml` file.

To enable the application to run as an ordinary Java application locally, without deploying it, run scripts and batch files are included in the apt__V<version-key> dir so that the versioned clients can be run locally.

Like *Make*[i], ant only compiles `.java` files that have changed by analysing file system time stamps. Ant targets are executed from the command line in the form `ant <target>`. Each target and its action is specified below:

clean	Deletes all the files and directories created by the build process.
init	Prepares temporary directories required for the build process.
compile-sp	Compile the SP Client to the `build` directory, this special target is required due to the complex coding of the SP classes.
compile	Compile the entire apt source tree to the `build` directory.
apt-jar	Package the contents of the `build` directory into the `apt__V<version-key>.jar` file. This file is created in the `dist/apt__V<version-key>` directory.
config-jar	Performs *String* replacements to files in the `config` dir, copies them to the `apt__V<version-key>/config` dir and packages this dir into a jar file. The jar file is necessary so the `.properties` files can be used in Java Web Start.
sign-jars	Sign the jars using the `aptdev` certificate. Jar Signing is required for Web Start.
prepare	Performs the *String* replacements of files so that they contain the <version-key> string. This is the dynamic creation of the run scripts and JNLP configurations.
upload	Uses scp to copy the `apt__V<version-key>` dir to the Web Start directory in the apt account on mcba5
upload-mistral	Uses scp to copy the `apt__V<version-key>` dir to the `APTAutomation-MultiVer` dir on mistral. Ready to be run.
source-tar.gz	Packages the source code into to the archive `apt__V<version-key>/source-tar.gz`

[i] Unix *Make* build tool. Traditionally for compiling programs written in C

doc-tar.gz	Packages the JavaDocs and content of the doc directory code into the archive apt__V<version-key>/apt-docs__V<version-key>.tar.gz

6.5 Version synchronisation

The APT System is a very dynamic software application, software changes on the server are likely to create incompatibilities with the client code. In addition to the flexibility of running multiple versions of the server, it is also necessary to synchronise the client code, so we can guarantee that the correct, corresponding version is run.

A significant portion of this problem is solved using JNLP and Java Web Start. A JNLP configuration allows an indefinite number of clients, distributed anywhere on the Internet, to automatically download and install the APT client application.

By omitting the <offline-allowed/> tag in the JNLP configuration file, the Web Start client is forced to reload the up to date JNLP information from the web server. If this operation fails, Web Start will not run the application.

Consequently the problem is simplified to that of ensuring that the JNLP configuration file is up to date and matches the version of the server that is running. This is achieved very simply by copying the apt-client.jnlp file to the Web Start web server whenever the server is started, overwriting the previous jnlp configuration.

The runServer script, used to start the server on mistral, copies the corresponding apt-client__V<version>.jnlp file to apt@mcba5/~apt/public_html/software/webstart/apt-client.jnlp. Thus guaranteeing that any new clients started will be using the correct version. Note that the apt-client__V<version>.jnlp is created at build time using the ant prepare target.

Every *version* or build has its own copies of all configuration files required to run the server.
The apt-client.jnlp file is generated at build time tagged with the version-key property specified in the ant build.xml.

However, this elegantly simple solution is not completely correct. If the server is started after the client software has loaded, there is no guarantee that the jnlp file used to start the client corresponds to that of the server. This is unlikely to ever be a problem since restarting the server while the client is logged in will cause the client software to fail, and attempting to login to an incompatible version of the server is also likely to fail. Both of these scenarios will prompt the user to restart the client, forcing JNLP configuration to be reloaded, and subsequently eliminating the problem.

In the unlikely event of the client successfully logging in to a different version of the server a runtime check can be performed. This is currently not implemented.

6.5.1 External libraries

The solution discussed previously must be further developed to account for the versioning of the library files that the APT system uses. The upgrading of third party jar files must not compromise the ability of older versions or the APT to use the *original* versions of these libraries.

A possible solution could be to simply package all the required jar files within the APT deployment directory, such that each version of the APT has its own copy of the libraries. This will work, although it is very inefficient. For example, suppose a trivial change is made to the apt.jar file and deployed as a new version. Web Start clients will be forced to download the entire application again, since it considers the library files to be different, consequently defeating the purpose of using Web Start in the first place. Likewise, for the developer, deployment of the new version will require uploading of all the library files to both the web server and mistral. Given that the jar files alone have reached up to 2MB in size this could take some time.

A better solution is to store libraries together, and simple monitor the changes to this directory. Historical uses of the jar files can be preserved as long as the following two rules are obeyed.

- No library file[i] is ever overwritten.

  New libraries must simply be added to the lib module with a different file name. Thus preserving the existing references in other versions of the APT. The APT configuration files must be modified to now reference the new library.

- All usages or library files must be specifically referenced in configuration files.

  Thus enabling alternate libraries to be referenced in the future under a different name. As opposed to setting the `java.ext.dirs`[ii] system property.

When used in conjunction with Web Start, clients will only be required to download resources that have changed. Also, if the naming convention shown in Figure 6-1 is used, the JARDiff functionality (only available in the `JnlpDownloadServlet`) will enable even faster download times.

6.6 Uploading

Once the apt__V<version-key> dir has been created using the ant-prepare target the application is ready for deployment. It must be copied to `mcba5` and to `mistral`. Mcba5 is the host used to subsequently deploy the Client applications using Web Start, and mistral is the live server connected to the APT hardware. In the future it will be possible to run the server application using a command line JNLP implementation, reducing this upload time. However, a more fine grained level of control on the server side is preferred. A dependency on mistral's unreliable Internet connection must not prevent the operation of the telescope.

SecureCopy is used to perform the file transfer. Scp is an open source, secure file transfer utility available on both windows, UNIX and Linux. Instructions on installing scp on windows are included in Appendix C.1.1.

---

[i] Any file in the `/lib` module

[ii] All `jar` files in the `java.ext.dirs` directory are implicitly added to the `CLASSPATH`

The ant upload targets discussed previously are simply calls to the scp command line tool. The deploy directory is uploaded to mcba5, and then to mistral to optimize network bandwidth for developers operating on slow connections[i]. The entire application can be compiled and deployed from a 56K modem connection in approximately 8 minutes.

6.7 Conclusion

This system allows any authorised user to checkout any version of the software to any development environment, then compile and deploy both the server and the clients using two simple commands. All this is done without compromising the working versions of the software. It is also compatible with *minor* changes to the build system itself, provided the core principle of the apt__V<version-key> directory are preserved. This directory must completely encapsulate a version of the software.

Since this deployment framework was introduced, several versions have been successfully deployed on mistral using this system allowing the APT operator to rapidly switch between different versions of the software.

[i] It is assumed that the connection from mcba5 to mistral is faster than the developers workspace to mistral.

7 APT suggestions and enhancements

7.1 Introduction

This Chapter contains a collection of improvements designed to increase the reliability and functionality of the APT system. These improvements range from hardware and software upgrades to the development process itself.

7.2 Hardware

7.2.1 Automated changing of astronomical filters

Currently, the switching of astronomical filters (see Appendix E.4) on the APT is a very tedious process. Automation if this procedure would expand the remote observing capabilities of the APT. Software control of this system will most likely be implemented as a CAN node.

7.3 Software

7.3.1 Configuration management

Configuration management deals with tracking the evolution of a software project. By formalising the development processes, its efficiency and reliability can be improved.

The software deployment system, developed as part of this thesis (see Chapter 6) is a significant part of the configuration management of the APT system, providing a multi-user, distributed method of development.

However, the APT system is lacking a *Change Management* strategy. Change management is essentially an ordered way to track information such as changes through the system. For example, what specific changes, either improvements or bug fixes, were implemented in a given release of the software ?

This information is very useful for several reasons:

- If a bug is detected in the current version of the software, configuration management information will help to determine how this bug was introduced, providing an answer to the question: *"What has changed ... ?",* which often results in the first clue as to what the problem may be, where is was introduced, and by who.
- Hardware may be updated or reconfigured such that previous versions of the code are now incorrect and may function unpredictably. For example, the Roof was recently rewired and subsequently recoded. All previous versions of the roof software are now incompatible with the hardware. This information must also be considered when choosing a *trusted* version of the software to roll back to in the event of a new bug being discovered.

Currently the `version.properties` file is used to track changes with each release.

7.3.2 Maintenance

The APT system relies heavily on several external software libraries and tools. Such as PTCS, DRAMA, JAS, JSDT, JSNMP, Ant, CVS, the Linux operating System, and many more. Maintaining these libraries and tools to the latest release version will reap may benefits such as improved features, reliability and performance.

7.3.3 Client SP server

For security reasons, the SP server only accepts connections from the *localhost*. Currently there is only an SP server run on *mistral*. Development is in progress, with the help of Keith Bannister, to incorporate an SP Server into the APT Client application. This would allow the execution of APT SP commands remotely. Once a sufficient set of commands are SP enabled, observers will no longer need user-level access to *mistral.*

The SP command set could be deployed using JNLP, and automatically versioned using the framework in Chapter 6.

7.3.4 Client error control

In many cases user actions will appear to have no effect due to some exception being thrown. In the current implementation, these exceptions are caught and logged. No further action is taken. The only way to determine the fate of a failed command is to examine the *Client Log* or the *Server Log* panels.

Although there are limited types of exceptions that can be thrown, the context in which they do so can narrow down the specific problem. This information should be extracted and conveyed to the user via a dialog message or some other stimulus such as an discoloured icon.

7.3.5 Improved process information

The *Process Manager* user interface component introduced in Chapter 5.3, needs to be accessible to all connected users, not just the user in control. It could also be extended to show which `ProcessSpace` a particular process is executing in.

7.3.6 Interactive diagnostics diagram

The APT Hardware Architecture diagram, shown in Figure 2-14, is a very useful resource for understanding the relationships and dependencies among the hardware and devices that comprise the APT systems. Knowledge that is vital for diagnosing faults in the system.

An interesting project would be to implement this diagram in software as an interactive user interface, such that components could be interrogated to obtain status information, and stimulate the user when events occur. Sounds and animations could be used to depict the operation of devices, such as a turning motor, or a pulsing cable to indicate data transfer. Ultimately the user should be able to identify the status of the system at a glance.

This is not a trivial project. The implementation would need to be flexible to cope with the constant changing of the system, such as the addition of new hardware, or the reconfiguration of existing components. Many corrections and adjustments were frequently made while this

diagram was developed. Also, additional hardware and software components will inevitably need to be added to provide information such as cable voltages, temperature monitoring etc.

7.3.7 JAS JXTA implementation

The JAS is primarily based on the JSDT[i] which has subsequently been discontinued, presumably in favour of project JXTA. The JXTA architecture provides several constructs similar to those provided by the JSDT which would allow an alternative transport layer for the JAS to be implemented. Richard Dixon and Chaker Khabbaz have been investigating this possibility in their theses.

7.3.8 Command line tool versioning

All the command line tools, shown in Figure 3-1 should be integrated to the CVS repository and subsequently included in the automated versioning system. Thus eliminating the possibility of accidentally using incompatible commands which may lead to unpredictable behaviour. All commands, including aptStart and aptStop should be migrated toward this system.

Eventually the entire software system should be managed by CVS and the deployment system. This would drastically simplify the process of rebuilding the APT system from a clean installation, if mistral was to fail.

7.3.9 Masterswitch command line tool

Unfortunately the SNMP Masterswitch control is only available through the GUI. A command line utility would prove very useful for both remote administration and scripting purposes. The text below shows a proposed usage of this command.

```
Usage: apt_masterswitch command [ command_options ]

Where command can be one of the following:
 status [outlet]
    Print the current state of the specified [outlet] in the form
    [number].[name]=[state]

    For example:
    $ apt_masterswitch status 1
    1.Anti Backlash = On

 switch [outlet] [state]
    Change the state of the specified [outlet]

 rename [outlet] newName
    Rename the specified [outlet] to "newName". Note that newName must be
    less than 20 chars.

 [outlet]  Can be either the outlet number {1..8} or the outlets name.
 [state]   On, Off, or Reboot
```

Figure 7-1 Proposed apt_masterswitch command line usage

[i] Java Shared Data Toolkit

Note that this command could be implemented as a SP command or as a very simple Java application, bypassing the JAS entirely.

7.4 Conclusion

The APT software control systems are maturing into a highly sophisticated synergy of a diverse collection of hardware and software components. The suggestions introduced in this Chapter are capable of further improving the systems functionality and reliability.

8 SkinnedTextField

8.1 Introduction

Given the complex architecture of the APT System, the development of a rich user interface in Java will require a high level of programming skills and proficiency with the Java Swing framework.

In order to gain Insight into the internal architecture of *Swing* itself, I decided to develop a customised, reusable *Swing* component, the *SkinnedTextField*, which uses images, as opposed to fonts, to render each letter within a text label. This concept is based on the creative images from Digit Mania(36). It is ideal for displaying the APT telemetry information and is also used in the *Spectrum Scanner* application discussed in Chapter 9.

This component can be seamlessly integrated into other Java applications. Particularly engineering and hardware interfacing systems due to its clear digital readout. The *Skins* can also be configured to simulate the *real* readouts on the hardware itself, enabling unfamiliar users to quickly identify the semantics of the data.

8.2 Requirements

- Dynamic switching of skins
- Synchronization without performance degradation
- Skin images may be of any size
- Not all images within a given skin have to be the same size

8.3 Design

There are four classes used to implement the SkinnedTextField:

- `SkinnedTextField`
  This is the component. Created directly by the user. It behaves in much the same way as a JLabel. More information on its API is included in Figure 8-1

- `SkinnedTextFieldDemo`
  Sample code to test and demonstrate SkinnedTextFields

- `SkinnedTextFieldManager`
  Currently there is no need for the user to access this class. It keeps track of all the SkinnedTextField instances and controls the popup menu.

- `TextSkin`
  This abstracts the mapping of images to individual characters.

```
/*  Abbreviated SkinnedTextField API */
public class SkinnedTextField {
  ...
  public SkinnedTextField() { ... }
  public void setSkin(TextSkin newSkin) { ... }
  public void setSkinMode(boolean mode) { ... }

  public synchronized void setText(String newText) { ... }
  public void getText() { ... }
  ...
}
```

Figure 8-1 SkinnedTextField API

8.4 TextSkin

The TextSkin Object, used by the SkinnedTextField has a very straightforward API. SkinnedTextFiled simply asks its current TextSkin object for an image to use to display a certain character. This is implemented in the `getImageIcon(char character)` function which is guaranteed to return a value. Default images are provided by TextSkin, as discussed in more detail in 8.4.2.

The API for the TextSkin is shown in Figure 8-2.

```
/*  TextSkin API */
public class TextSkin {
  ...
  public static final TextSkin defaultSkin = new TextSkin();

  /* return the image to display character */
  public ImageIcon getImageIcon(char character) {...}

  public static TextSkin loadSkinFromZip(File skinZipFile) {...}

  public String toString() {...}
  public String getName()  {...}
  ...
}
```

Figure 8-2 TextSkin API

8.4.1 Skin loading

Skins are loaded using private constructors accessed through `loadSkinFromZip(File skinZipFile)`. In most cases Skins are statically loaded by the SkinnedTextFieldManager when it is first referenced.

The majority of images for the skins, obtained from Digit Mania(36), unfortunately only provide images for digits. This is inadequate for the APT as RA and Dec displays require additional characters such as ':' and '+' to be supported.

In order to support skins downloaded from (36), as well as those I have extended to include additional characters, Skins are loaded by matching only those that are discovered in the zip file.

8.4.2 TextSkin zip format

TextSkins can be loaded from any zip file containing a collection of gif images complying with the naming conventions detailed below:

- All files must be in the root path of the zip file.
- Zip files must be named using `<SkinName>.zip`
- Each image in the zip file must be of the form

  `<IdentStr><SkinName>.gif`

  where `icon<IdentStr>` is variable name within TextSkin.java

- These `<IdentStr>` are NOT case sensitive, this is a weakness due to Java's ZipFile implementation not distinguishing case.

As each file within the zip file is processed, it's name is identified and it is then matched to a variable within the TextSkin object using the Java Reflection API.

This allows TextSkin zip files to support any number of characters. As a minimum, a TextSkin should provide a `default<SkinName>.gif` which will be returned by `getImageIcon(char character)` when the correct image is not supplied. If `default<SkinName>.gif` is not supplied, a global default image will be returned. As the global default image is likely to be of a different size and appearance to the current skin, it is likely to produce a non uniform output.

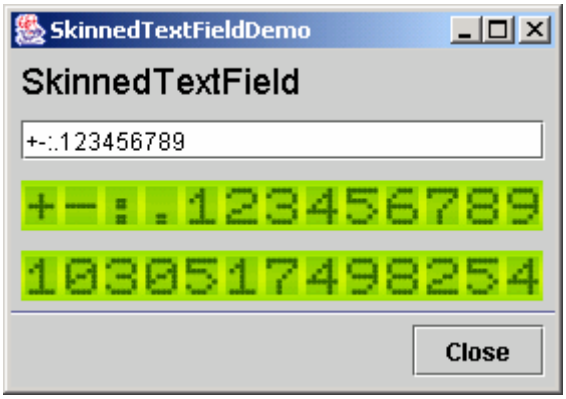
A sample listing of a `<SkinName>.zip` file is shown in Appendix F.4.1.

8.5 SkinnedTextFieldDemo

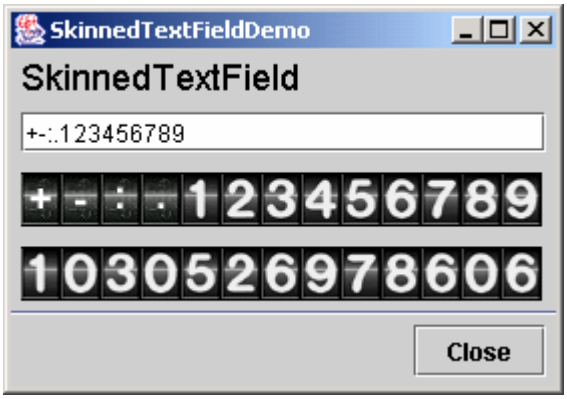
This is a simple application designed both to test the features of the SkinnedTextField framework and provide example code to guide other developers wishing to include SkinnedTextField in their applications.

It contains two SkinnedTextFields, the first displays the text from the JTextField above it, while the second shows the `currentTimeMillis()` [i] updated approximately every 100ms.

[i] This is the number of miliseconds since 12am, Jan 1 1970



BackLitLCD



57ChevySkin

Figure 8-3 SkinnedTextFieldDemo

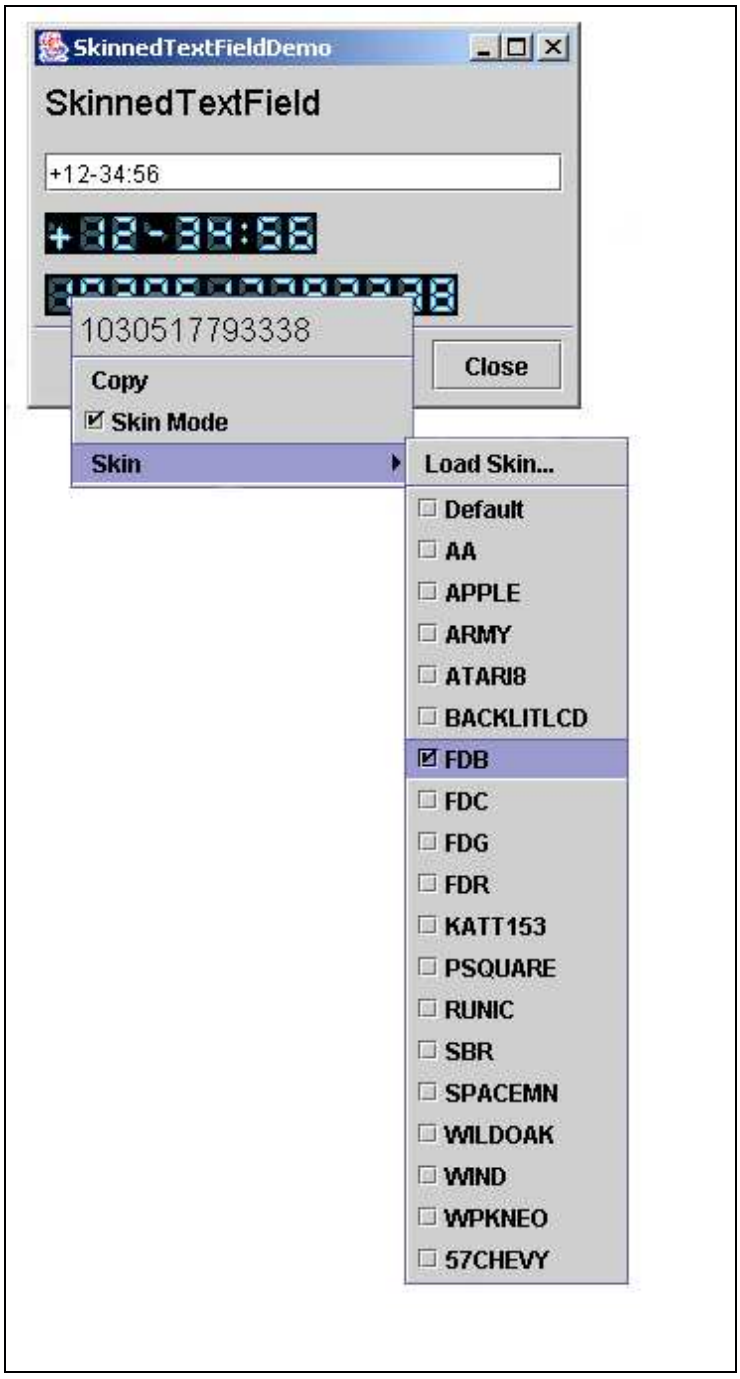


Figure 8-4 SkinnedTextField menu

Unfortunately, the Web Start deployment of SkinnedTextFieldDemo can not be distributed with Skins pre-loaded because the Skins must be deployed as zip files within jar files. A limitation of using Web Start.

8.6 Suggestions and enhancements

- Support for *Classes* of SkinnedTextFields.

  This would allow users display to have different areas of their application using different skins at the same time. Currently only one skin is supported across all instances of SkinnedTextField. This could be implemented by allowing multiple instances of SkinnedTextFieldManager.

- Dynamic creation of blank images.

  When incomplete skins are used and the global default image is required, the component can appear odd. The default icon could be dynamically created at load time based on the appearance of existing icons discovered in the TextSkin zip file.

9 CSIRO SEARFE project

9.1 Background

The SEARFE (Students Exploring Australia's Radio-Frequency Environment) project is designed to act as an educational resource for high school physics students as well as contributing to a national study of radio interference throughout Australia, geared towards Australia's bid for the SKA telescope.

The SKA is an international project to design, and ultimately build a radio astronomical telescope with an effective collecting area of one square kilometre (37). Unlike traditional radio-telescopes, the SKA will consist of many small antennae distributed across a large area. Together, these antennas will yield a collection area of one square kilometre, significantly greater than any radio telescope in existence. Currently Australia is a potential host country for the construction of the SKA.

The SKA Outreach Project is an effort by the CSIRO to study Australia's suitability and to increase the likelihood of being selected as the host country. The SEARFE project, a subset of the SKA Outreach project, is designed to involve students and to provide statistical data on the levels of radio noise throughout Australia, particularly in remote areas. SEARFE is sponsored by IBM Australia, BAE Systems Australia, Perth Observatory and Australian Geographic. This Chapter will provide an overview of my involvement in the SEARFE project as the developer of the *Spectrum Scanner* software.

9.2 Introduction

The *Spectrum Scanner* software is designed to be used by high school students to record radio interference levels in their local area. The software uses a serial protocol to interface to the AOR-AR3000A radio receiver and record the *signal strength* at various frequencies.

Although initial versions of the software were deployed on IBM laptops[i] running the Windows operating system, a larger user base (of unknown platforms) is anticipated in the future. The Java language's platform independence will allow for seamless portability to these other platforms.

A prototype of the software was initially developed by George Warr. Although the concept was proven to work, there were several fundamental problems with this initial implementation:

- Unreliable
    - Crashed when switching modes
    - Couldn't scan twice, needed to restart the program
- No logging
- Visualisation errors
    - Inconsistent data between plots
    - Colour scale not correct
- Limited user interface
- Could not save plots

[i] 800x600 resolution, 2GB HDD, P133, 128MB Ram

This prototype was used as a basis for preparing the requirements of the Spectrum Scanner application.

9.3 Requirements

The primary purpose of the software is to interface to the radio receiver and allow recording of signal strength readings across a given frequency range whilst providing a mechanism for visualising the data as it is acquired. This broad requirement has been further refined to the following points:

- Spectrum scanning

  Users must be able to enter scan parameters such as start frequency, stop frequency, increment or step size, dwell time, and other conditions, then instruct the receiver to perform the scan at a specified time. Users must be able to cancel this scan.

- Persistent data files

  Every scan must be accompanied by a data file storing all the information for archiving purposes. This data file must store enough information to enable the user to recreate an identical scan. Circumstantial data, such as date, time, and any other experimental notes, must also be stored for scientific completeness. These data files must be human readable and accessible to other software systems for analysis. These data files must also be able to be loaded back into the Spectrum Scanner application for analysis.

- Data visualisation

  The majority of scans are expected to run for considerable amounts of time. There needs to be a mechanism for visualising data as it is acquired to provide the user feedback.

- Robust, intuitive user interface

  The primary user base for the software are inquisitive high school students. For this reason, it must be easy to use and provide appropriate dialog messages if an error is encountered.

- Fault Tolerant

  The software must continue to run if the receiver is disconnected. For example, unplugging the serial cable whilst the receiver is scanning should result in an appropriate warning to be displayed. The software should also automatically resume scanning when the connection is restored.

9.4 Hardware

Figure 9-1 AOR – AR3000A Radio Receiver

The software interfaces to a AOR-AR3000A professional radio receiver. The features utilised by the *Spectrum Scanner* are as follows:

- Frequency Range 100KHz – 2036MHz
- Listening Modes
    - NFM Narrow Band FM
    - WFM Wide Band FM
    - AM Amplitude Modulation
    - USB Upper Side Band
    - LSB Lower Side Band
    - CW Continuous Wave
- Signal Strength
- RS232 Serial Interface

Control can be switched from the receiver keypad to the serial port input via a rear panel switch. This is important to note as the serial port connection will not respond if this switch is not set appropriately.

The Java Communications API is used to interface to the receiver using the serial interface. The Java CommAPI is a standard extension to the J2SE SDK. It provides support for RS232 (Serial) and IEEE11284 (Parallel) interfaces.

9.5 Architecture

As shown in Figure 9-2, the communication to receiver and its command set are encapsulated by the rf`sv.recevier.AR3000A` object. This AR3000A object is exclusively used by a `SpectrumScanner` object which manages the scan. Scan events are propagated to registered GUI and `ScanData` components using an *Observer* design pattern (43). This enables dynamic visualisation of the data as it is acquired. Alternative implementations of the SpectrumScanner could be implemented to utilise the receiver in different ways. For example, a more intelligent Scanner would be able to identify stronger signals and then rescan at a higher resolution (i.e. smaller frequency increments).

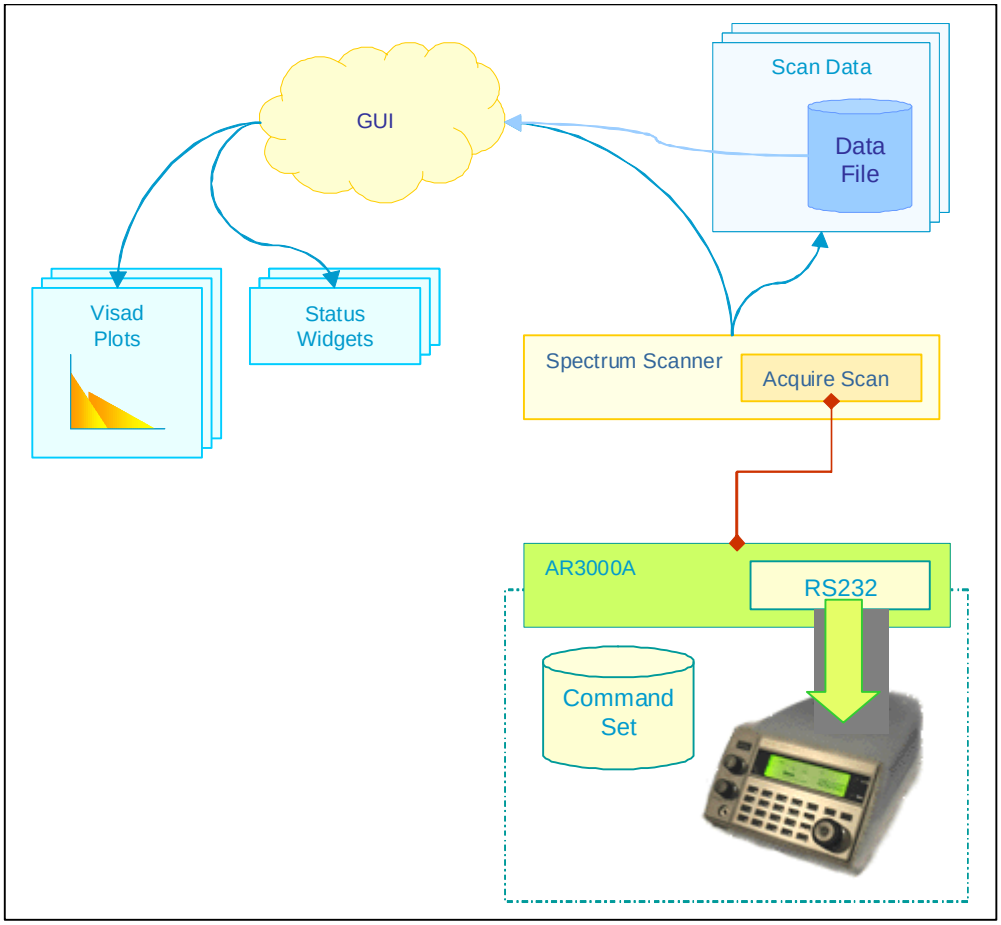


Figure 9-2 Spectrum scanner software architecture

9.5.1 Data files

The data files are written incrementally by the `ScanData` object to ensure that data is correctly recorded even if there is a software or hardware failure during a scan.

Originally, data files were stored as a comma delimited text file, to enable data files to be easily imported into other applications for further analysis, such as Microsoft Excel. However, these files had to be manually parsed to be loaded back into the Spectrum Scanner application. The overhead of maintaining this parsing mechanism posed a problem to further development.

For this reason, the data files were converted to XML documents. XML is an ideal storage mechanism for scientific data of this nature due to its portability and flexibility.

A sample data file is included in Appendix F.3.1.

9.6 User interface

The main application window shown in Figure 9-3 provides access to all the data files currently loaded in memory, access to the receiver console, and can launch the *Spectrum Scan Wizard*, used to configure the receiver for a scan.

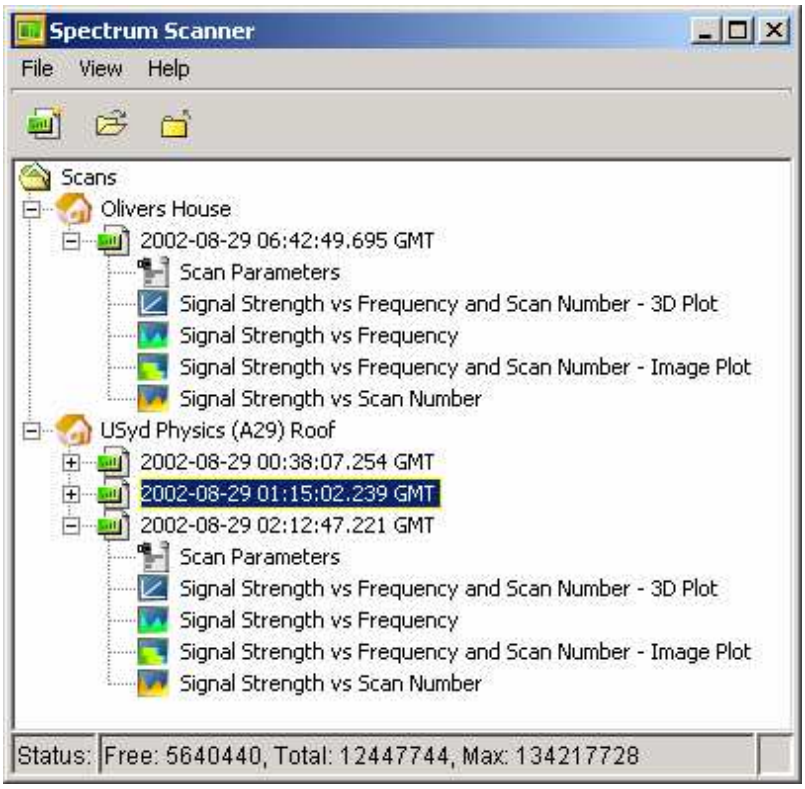

Spectrum Scanner
File View Help
Scans
Olivers House
2002-08-29 06:42:49.695 GMT
Scan Parameters
Signal Strength vs Frequency and Scan Number - 3D Plot
Signal Strength vs Frequency
Signal Strength vs Frequency and Scan Number - Image Plot
Signal Strength vs Scan Number
USyd Physics (A29) Roof
2002-08-29 00:38:07.254 GMT
2002-08-29 01:15:02.239 GMT
2002-08-29 02:12:47.221 GMT
Scan Parameters
Signal Strength vs Frequency and Scan Number - 3D Plot
Signal Strength vs Frequency
Signal Strength vs Frequency and Scan Number - Image Plot
Signal Strength vs Scan Number
Status: Free: 5640440, Total: 12447744, Max: 134217728

Figure 9-3 Main control window

9.6.1 Scan wizard

The *Spectrum Scan Wizard* consists of three consecutive panels allowing the user to input scan conditions, parameters and specify which plots to use to display the data as it is obtained. These panels are shown in Figure 9-4, Figure 9-5 and Figure 9-6 respectively.

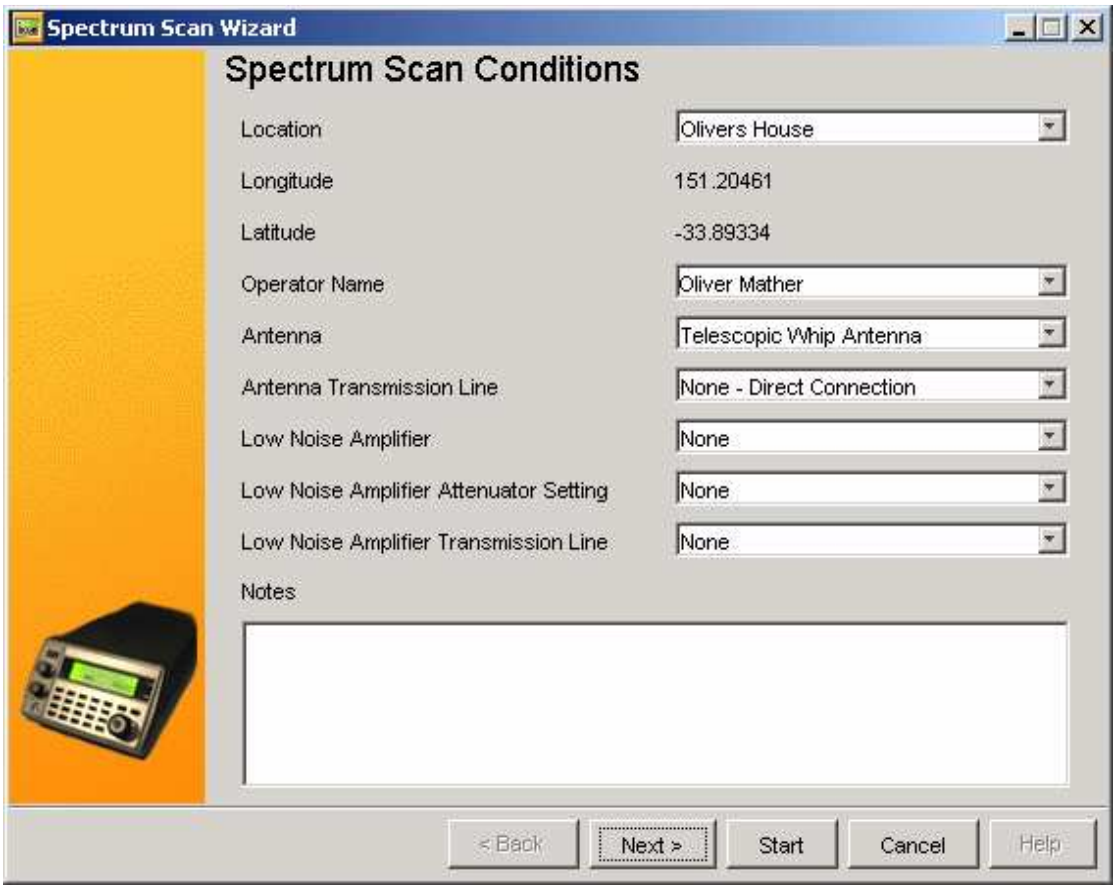


Figure 9-4 Scan conditions panel

Figure 9-5 Receiver parameters

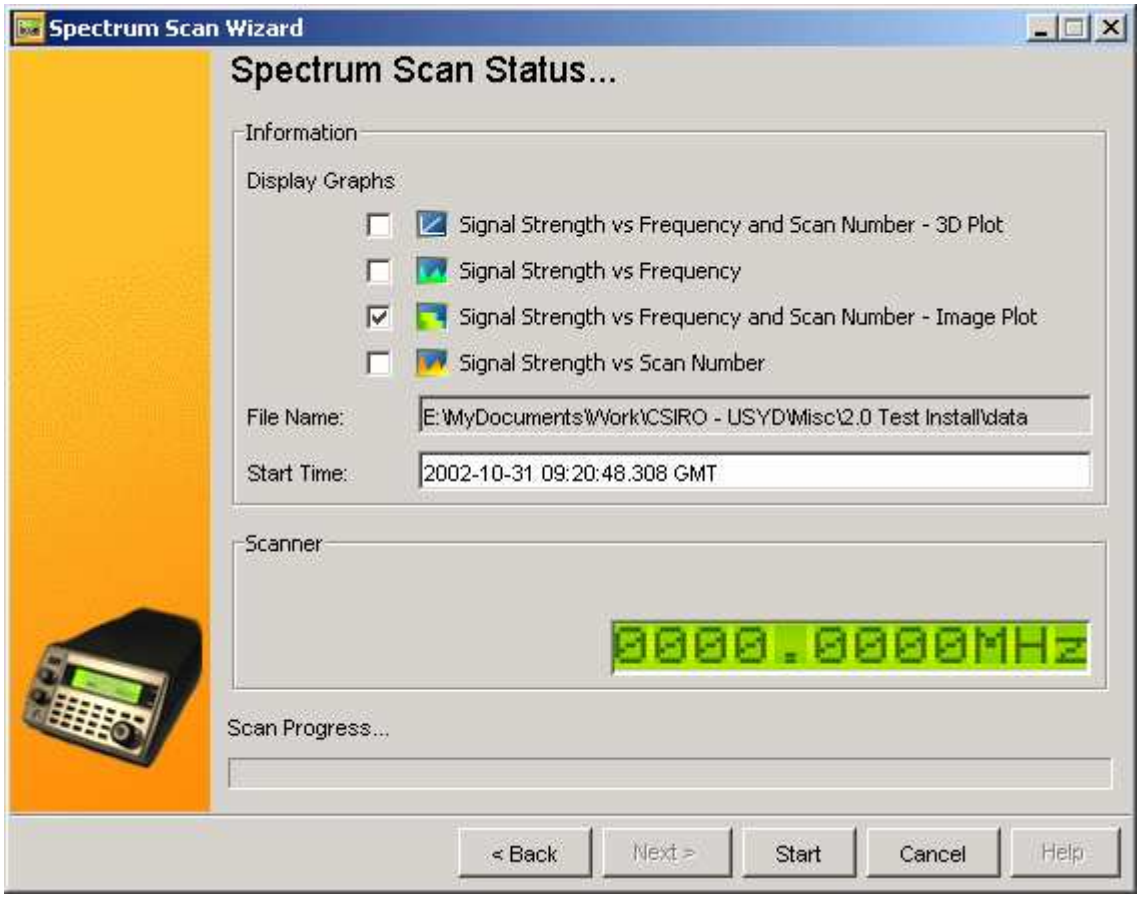


Figure 9-6 Scan status panel

9.6.2 Data visualisation

VisAD was chosen as a graphical package primarily because of its ability to plot image graphs, as shown in Figure 9-8. The VisAD library is a freely available *"Java component library for interactive and collaborative visualisation and analysis of numerical data"* (41). Four kinds of plots were defined for use in the Spectrum Scanner application. These are shown in Figure 9-7 through Figure 9-10.

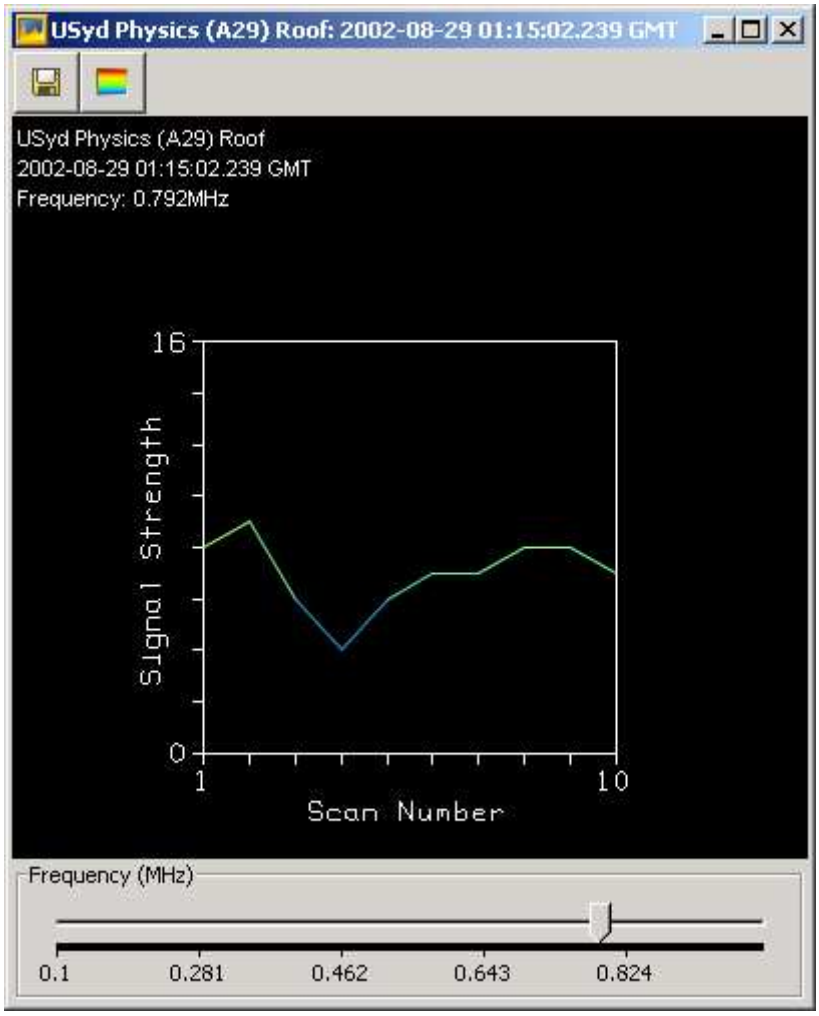


Figure 9-7 Signal strength vs. scan number

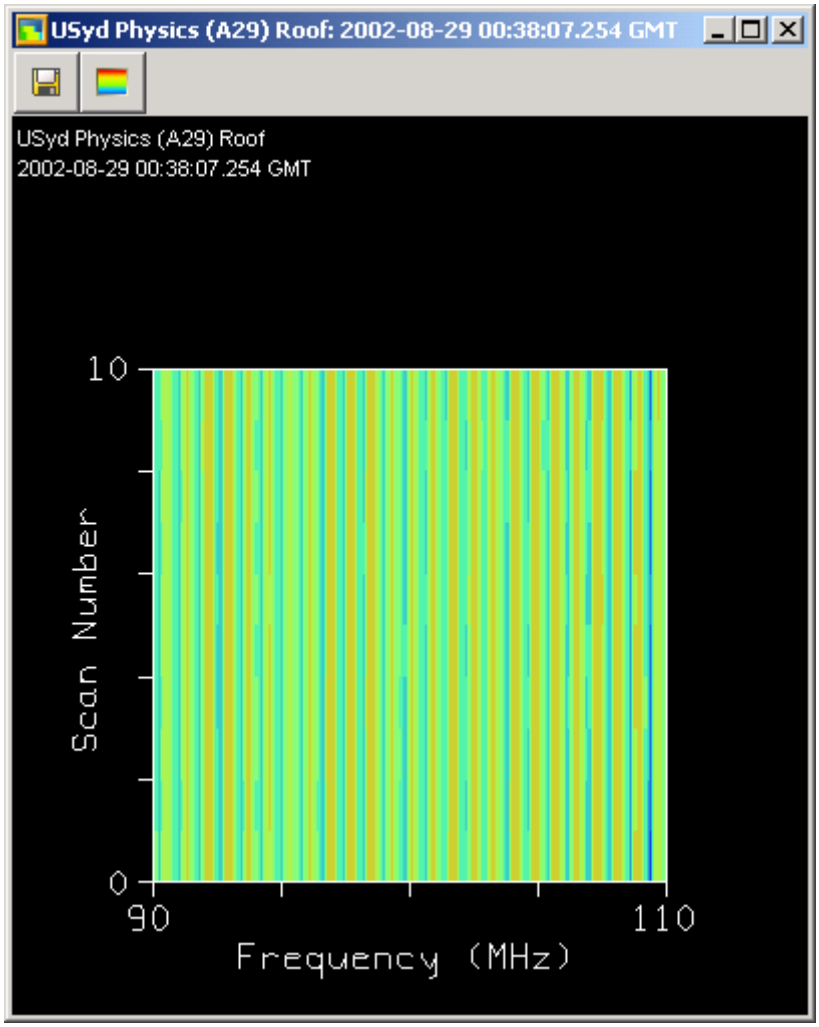


Figure 9-8 Signal strength vs. frequency and scan number

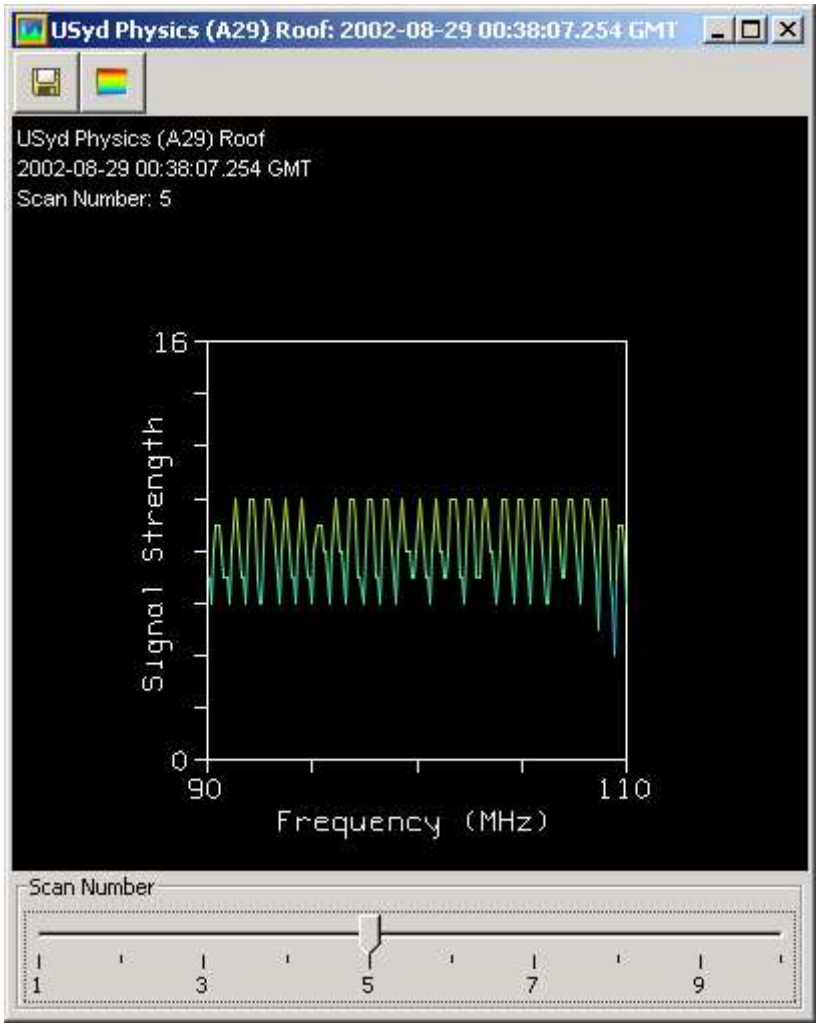


Figure 9-9 Signal strength vs. frequency

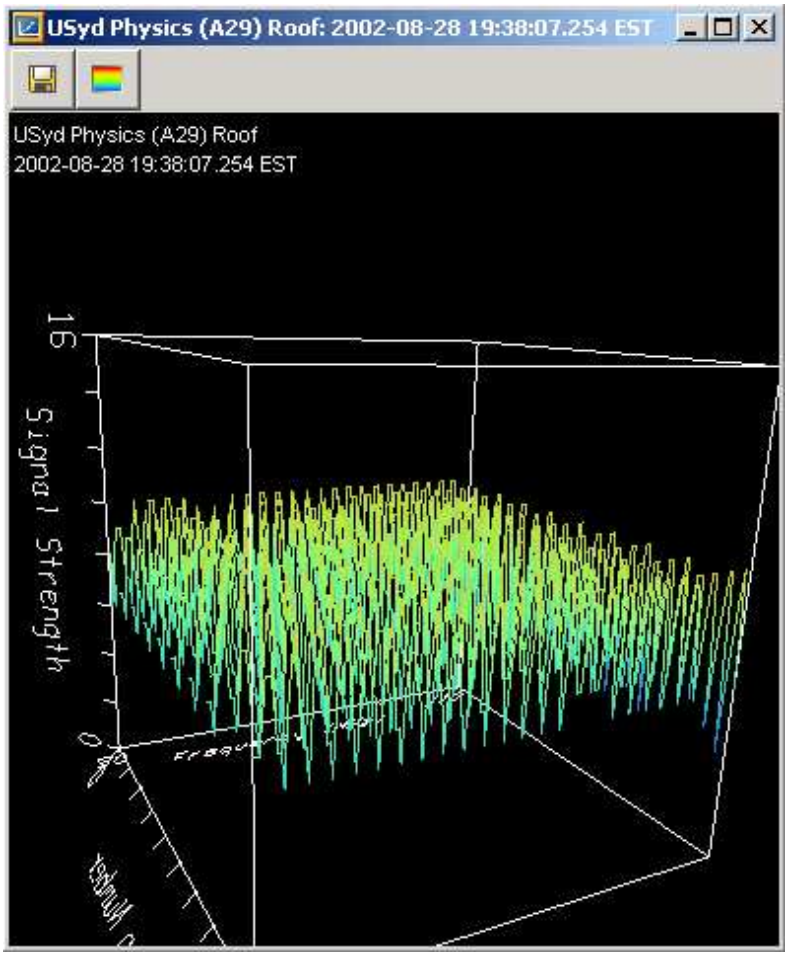


Figure 9-10 3D plot

9.7 Suggestions and enhancements

Version 2.0 of the Spectrum Scanner satisfies all the requirements outlined in 9.3. Since its deployment, very few issues and bugs have arisen. Most feature requests are for improved usability and data analysis facilities.

9.7.1 Visualisations

- The VisAD plots are only configured to plot the entire data set, as opposed to a more manageable subset of this data. Users often want to perform a very large scan and *zoom* in to analyse a particular range. This is a very high priority feature to add.

- The signal strength is recorded as an integer from 1 to 16, and this value is plotted linearly in each plot. For scientific analysis, it is necessary to plot exponentially (2^n) as opposed to linearly (n). Dynamic switching of the axes is not a trivial exercise in VisAD.

- Axes on the 3D plot can appear inverted and cause confusion. Rotation of the plot can make these labels unreadable. This is a limitation of the VisAD toolkit and there appears to be no solution to this.

- The XML data files also utilise XML style sheets to automatically format the data into comma delimited text. These style sheets could be improved to allow the data to be displayed in a presentable form on the web. Easing collaborative analysis.

- Each visualisation window is always placed on the top left corner of the users desktop, often covering other plots, causing confusion. A tiling or cascading window placement strategy could be implemented to overcome this.

9.7.2 Data files

- Currently the user interface can appear to hang when very large files are loaded. This is because the file loading process is executed by the *Swing* event thread. This can be trivially overcome by creating a new `Thread` object.

- A DTD (Document Type Definition) should be developed as a specification for the data files. This would enable data files to be validated as well as other software developers to write analysis software.

9.7.3 Web Start

Initial versions of the software were simply deployed as zip files. Web Start deployment was not implemented for several reasons. Firstly, the donated laptops were not equipped with a network interface or modems. This, and the fact that they were to be sent to very remote areas of Australia, means that they are unlikely to ever have Internet access. Thus negating most of the benefits Web Start provides. Also, the CommAPI relies on native libraries which must be manually installed into the users Java installation. At the time, overcoming these complications to enable Web Start deployment was considered a low priority.

However, given the success of the Spectrum Scanner software, and the interest in its use at other potential SKA sites, the user base may rapidly increase. Managing deployment and software upgrades to such a large and divers set of users can be made trivial through the use of JNLP and Web Start.

9.7.4 Receiver portability

Although there is no direct need for the software to interface with radio receivers other than the AR3000A, the requirement of adding this feature in the future must be anticipated. This current architecture is moderately flexible and capable of achieving this. However, a more defined process should be integrated to enable other developers to add support for different receivers.

9.8 Conclusion

The Spectrum Scanner software has been used successfully by several schools throughout Australia with very few bugs surfacing. Most of the problems encountered have been overcome by simple workarounds. Development will continue as the SEARFE project expands. The project has attracted international interest from European organisations and the SETI[i] Institute in the United States.

[i] Search for Extra Terrestrial Intelligence

10 Conclusion

10.1 Introduction

Despite the fact that Java's platform independence and design principles are focussed on abstracting and isolating the programmer as much as possible from the architecture of its host system, it has been used to successfully implement hardware control components for both the APT and the Spectrum Scanner application. This Chapter details reasons for this success and documents the common characteristics of hardware control systems that may be exploited to achieve similar results in other systems.

10.2 Java as a hardware control system language

A *Hardware control system* is a software application designed to manage a set of distinct, yet interconnected components to enable them to work together effectively in order to achieve a higher purpose. The APT system, for example, consists of a plethora of hardware devices and components that enable its remote operation.

A distinction must be made between the concepts of *hardware interfacing* and *hardware control*. Hardware interfacing refers to the lower level implementations of functions on the device itself whereas *hardware control* is focussed on the logical operation of devices made possible by the hardware interfacing. Devices and functions can be abstracted by utilising these hardware interfaces.

Once this hardware abstraction layer is created, the complex logic of the system can be built. The role of Java is to provide this control layer. The advantages of using Java for this are as follows:

- Portability
- Maturity
- Quality documentation
- Easy to debug
- Trusted libraries
- Memory management and garbage collection
- Multithreaded environment
- Object oriented design

The Java language supports several techniques for interfacing to the hardware:

- JNI – Java Native Interface. This is used in the JCAN module developed by Keith Bannister to interface to the CAN controller device driver
- File system. Many system properties can be obtained by parsing a particular file which is updated by another source.
- Java Communications API. The RS232 serial protocol is used by the *Spectrum Scanner* software to interface to the radio receiver.
- Java can invoke external processes using `Runtime.getRuntime().exec()`
- Strong network protocols support. For example the Masterswitch is controlled via its Ethernet interface.

10.3 Failure and fault analysis

As the complexity of any system grows, so does the likelihood of a individual components failure. The consequences of this failure are unique to every system. This highlights the need to analyse the system and identify faults that can occur and how these faults will propagate through the system, on both a hardware and a software level. The following questions should be considered when designing a control system:

- What potential faults can occur and how serious are they?
- How can software accurately become aware of these faults ?
- What action can be taken to recover ?
- How will this fault propagate to other devices in the System ?
- Can additional hardware be added to the system to more effectively diagnose these faults ?

This information would encourage the development of a more reliable software system capable of detecting and recovering from failures.

10.4 Logging analysis

10.4.1 Overview

In virtually every complex software system, various log files are used for monitoring and debugging the software. This characteristic is shared by both the APT and the Spectrum Scanner software through the use of the `java.util.logging` framework. Operating Systems are also an example of this. Unix/Linux based operating systems log system messages to `/var/adm/messages`[i] whereas WindowsNT messages can viewed with the *Event Viewer*.

In any software failure, analysis of these log files is generally the standard procedure for identifying the cause of the problem. Particularly when the system is controlled remotely. This analysis can often be very time consuming due to the verbosity and sheer size of log information.

Command line tools such as `grep, tail, more, and less` are often used in this kind of analysis. These are inadequate, particularly for Java based systems, for several reasons:

- Log messages can be on more than one line (eg Java stack traces).
- Some log messages are longer than 80 characters.
- Log messages cannot be filtered according to their severity.
- Searches are limited to plain text as opposed to log record types and attributes.

Given these shortcomings of the current log analysis tools, a specification for an *ideal* tool can be defined.

10.4.2 Analysis tool specification

The aim is to provide a graphical based tool to analyse log file data using searching, filtering and masking techniques. The power of this tool is drawn from the fact that `LogRecord` data types can be searched, rather than just plain text.

[i] The path of the messages log file varies between differnts distrubutions

An implementation based on the `java.util.logging` framework is capable of achieving this. Searches could be performed on `LogRecord` objects using sophisticated implementations of the `Filter` interface.

Although the *Chainsaw* (http://logui.sourceforge.net/) project adopts similar concepts using the `log4j`[i] framework, there is a potentially significant market for such a tool.

[i] http://jakarta.apache.org/log4j/

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A. Glossary

AAO	Anglo Australian Observatory
APT	Automated Patrol Telescope
CAN	Controller Area Network
CCD	Charge Coupled Device - Camera
CVS	Concurrent Versions System
Dec	-Declination "Latitude +=90"
DRAMA	Inter-process Communication mechanism developed by the AAO
GCN	Gamma-Ray Co-ordinate Network
GRB	Gamma Ray Burst
J2SE	Java 2 Standard Edition Platform
JAS	Java Automation System
JDK	Java Development Kit
JNLP	Java Network Launch Protocol
JSDT	Java Shared Data Toolkit
JXTA	Project Juxtapose – Sun Microsystems Peer to Peer Architecture
LDAP	Lightweight Directory Access Protocol
LST	Local Sidereal Time
MACRO	Motion And Control Ring Optical - Delta Tau
MIB	Management Interface Board (APC Masterswitch)
MIB	Management Information Base (SNMP)
MJD	Modified Julian Date
NMS	Network Management Station
NTPD	Network Time Protocol
OID	Object Identifier
PDU	Protocol Data Unit
PMAC	Programmable Multi-Axis Controller
PTCS	Portable Telescope Control System - Jeremy Bailey AAO
RA	Right Ascension = Longitude - measured in hours,minutes,seconds.000
RMI	Remote Method Invocation
ROTSE	Robotic Optical Transient Search Experiment
SDK	Software Development Kit
SEARFE	Students Exploring Australia's Radio-Frequency Environment
SKA	Square Kilometre Array
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
TAI	International Atomic Time
THI	Telescope Hardware Interface
UDP	User Datagram Packet
UPS	Uninterruptible Power Supply
UTC	Coordinated Universal Time
Vignetted	The viewing are is obscured in some way by an object in the foreground.

B. JAS programming techniques

B.1. Introduction

This appendix is intended to be a simple programming guide for interacting with the APT using the JAS. It is intended to be used as a reference for code patterns and techniques when adding or modifying the APT-JAS application.

B.2. JAS message sender

Many of the subsystems at the APT are responsible for sending telemetry information to clients. The `JASChannel` object supports two methods for sending `JASMessages`:

- `JASChannel.sendToAll( JASMessage msg )`
- `JASChannel.sendToClient( JASMessage msg, String client )`

A `JASMessage` object can be extended to allow any Java object[i] to be distributed to JASClients. In the case of the APT, `JASMessages` used for telemetry information are a collection of <key>/<value> paired data, stored in a Java `Map` object, sent to clients as a `JASStatusMessage`.

The `PTCS_CHANNEL_3SEC JASChannel` sends a `PTCSStatusMessage`, which is actually a subclass of `JASStatusMessage`, every three seconds. Note that a `JASStatusMessage` alone is sufficient for this purpose. The `PTCSStatusMessage` is intended to provide more efficient customised serialisation.

B.3. BoundComponent framework

`JASClients` receiving `JASMessages` are typically designed to display this information in a GUI of some sort. The *BoundComponent* framework developed by Keith Bannister in (52), was designed to simplify this process.

`BoundComponents` were designed to be used with `JASStatusMessages`. When a `JASStatusMessage` arrives on a channel, the `JASStatusMessageManager` updates the values of all the GUI components registered to it. Each GUI component is *Bound* to a specific *key* within the Map of data stored by the `JASStatutsMessage`.

The `BoundComponent` framework has been extended to support a richer set of GUI components. `JASChatMessageManager` and `JASLogMessageManagers` have been introduced to handle `JASChatMessages` and `JASLogMessages` and function in a similar fashion to the `JASStatusMessageManager`.

B.4. Creating JAS commands

[i] All objectcs contained by in JASMessage must be serializable

The core of the JAS system revolves around its ability to execute commands. To add a command to the APT system is a relatively simple process. Several JASChannels are designed to receive Commands.

B.4.1. JASCommand object

```
public class MyCommand extends APTCommand {

  // Command parameters as private variables
  private int someData;

  private transient Logger logger = Logger.getLogger( getClass().getName() );

  public Object execute(Process parent) {
    // Execute something...
    ...

  }

  public String getDescription() {
    return "Do Something with someData";
  }
  ...
  public String getName() { return getClass().getName(); }
  public String toString() { return "DO SOMETHING CMD";}
}
```

Figure B-1 JASCommand object

B.4.2. Installing commands

Once the command objects have been created, they must be added to the appropriate command set, as shown in the code below.

```
  static final Class[] sysCmds = {
                    RoofStatusBroadcaster.class,
                    SendAPTPropsCommand.class
  };

  static final Class[] genCmds = {
                    ImageListCommand.class,
                    ImageRetrieveCommand.class
  };

  static final Class[] privCmds = {
                    APTSetPropertyCommand.class,
                    ImageExposeCommand.class,
                    LightsCommand.class,
                    ParkForRoofMovement.class,
                    ParkTwilightFlat.class,
                    ParkZenith.class,
                    ParkZeroHour.class,
                    PtcsMoveOffsetCommand.class,
                    PtcsMovePOffset.class,
                    PtcsSetBaseCommand.class,
                    PtcsSetOffsetCommand.class,
                    PtcsSetPOffset.class,
                    PtcsSlewCommand.class,
                    PtcsSetSystemCommand.class,
                    RoofCommand.class,
                    RoofRefresh.class,
```

```
                    LogCommand.class,
                    MasterswitchSwitchOutletCommand.class,
                    MasterswitchRenameOutletCommand.class
    };
```

Figure B-2 APT command sets

B.5. JAS channel monitoring

In many cases, it is useful to be able to determine, when a client joins or leaves a JAS Channel. For example, when the Roof software[i] detects that a new client has joined `Channels.ROOF` all the roof telemetry is sent to that client. From this point onward, roof information is only sent when it has been requested[ii], or when it changes.

```
/* Procedure for discovering when new clients have been added to a
 * JASChannel
 */
...
jasChannnel.getChannel().addChannelListener( new ChannelWatcher() );
...
// Extend the JSDT ChannelAdaptor
private class ChannelMonitor extends ChannelAdaptor {
    public void channelConsumerAdded(ChannelEvent event) {
        // Extend the JSDT ChannelAdaptor
    }

    public void channelConsumerRemoved(ChannelEvent event) {
        // Extend the JSDT ChannelAdaptor
    }
}
```

Figure B-3 Implementing a ChannelMonitor

This implementation highlights one of the flaws in the JAS, its dependence on the JSDT. The `jasChannnel.getChannel()` method returns a JSDT `Channel` object. Consequently, the `ChannelAdaptor` and `ChannelListener` classes are also JSDT objects.

[i] apt.modules.roof
[ii] Using apt.jas.BroadcastRoofCommand

C. Software tools

C.1. CVS - Windows

Instructions for accessing the APT CVS repository on Linux based machines is available from Keith Bannister's APT Software page (53). These instructions are included to simplify the installation and configuration of CVS and SSH on Windows.

Note that these instructions below will not work for the *cvsanon* user.

C.1.1. Install SSH

An excellent ssh implementation for windows can be downloaded from http://www.networksimplicity.com/openssh/. Simply extract the `openssh34-3.zip` file and run `setup.exe`. Accepting the default installation options is recommended.

Place the `C:\Program Files\NetworkSimplicity\ssh` in the `PATH` by doing either:

- `C:\set PATH= C:\Program Files\NetworkSimplicity\ssh;%PATH%`

or

- Right click *My Computer -> Properties* and from the *Advanced* tab select *Environment Variables.*

Create your private and public keys:
```
C:\ssh-keygen –t dsa
```

Accept the default settings, do not enter a pass phrase for your key. This will hinder automated logins.

Now, setup automatic authentication. Ensure that a `.ssh` directory exists on the remote host. This will automatically be created whenever you first ssh to another host.

Copy your public key to the remote host:
```
scp "C:\Program Files\NetworkSimplicity\ssh\.ssh\id_dsa.pub"
user@remotemachine:/~/.ssh/mypublickey
```

From the remote host, add your public key to the list of authorized keys:
```
[user@remotehost:~]cat  ~/.ssh/mypublickey >> ~/.ssh/authorized_keys2
```

Now, you should be able to ssh to `remotehost` without entering a password. If there is a problem, ensure that the `authorized_keys2` file does not have a corrupt entry.

C.1.2. Install CVS

CVS can be downloaded from http://www.cvshome.org. Simply download the latest stable build. This guide was prepared using `cvs-1-11-2.zip`. This zip file contains one file, `cvs.exe`, which must be placed in you `PATH.` This can be done in the same fashion as shown above.

All that remains is to set the CVS_RSH environment variable. This should be set to the path of the ssh.exe file.

```
set CVS_RSH=C:\Program Files\NetworkSimplicity\ssh\ssh.exe
```

C.1.3. Checkout the code

Create a cvs-workspace directory on your local machine.

```
C:\mkdir cvs-workspace
cd cvs-workspace
```

Now, checkout the modules.

```
cvs –d :ext:username@mcba5.phys.unsw.edu.au:/home/cvsroot checkout apt
```

Note that the `–d :ext:username@mcba5.phys.unsw.edu.au:/home/cvsroot` string can be omitted if `CVSROOT=:ext:username@mcba5.phys.unsw.edu.au:/home/cvsroot`.

C.1.4. CVS user interfaces

Several CVS GUI tools are available free on the Internet.

- http://www.tortoisecvs.org is one of the more popular as it integrates directly into Windows explorer.
- http://www.wincvs.org is also an excellent resource for help configuring cvs on Windows.

D. SNMP overview

D.1. Architecture

The Simple Network Management Protocol (SNMP), is a standard designed to allow the remote management of devices across a network. This standard, defined in (18), facilitates communication between an *SNMP Agent* (managed device), and a *Network Management Station* (NMS).

Device management is achieved by a simple system of *getting* and *setting* of attributes on the remote device. Attributes, or *Object Identifiers* are defined in the agent's *Management Information Base* (MIB), a repository containing definitions of all the OID's within an agent.

Objects within an agent belong to a particular SNMP *Community*[i]. The community name, known only to the system administrator, is used to authenticate messages.

Communication is achieved via SNMP Messages, as shown in Figure D-2. Sent as UDP packets, they contain three pieces of information:

1. SNMP version number. Included to guarantee the correct dissection of packets in an environment where multiple SNMP agents, supporting different versions, exist.
2. Community name.
3. One or more *Protocol Data Units* (PDU's). A PDU typically contains a list of OID's and their corresponding values.

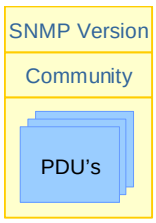

Figure D-1 SNMP message

There are three kinds of SNMP messages:

- Request
  - GET, Read information from the SNMP Agent corresponding to an attribute of the managed device.
  - GET NEXT, Do a get on the next attribute in the tree. This is used to traverse each OID within the SNMP agent, otherwise known as an *SNMP-walk*.
  - SET, Set the value of an attribute of a managed device.
- Response

[i] Typically, all objects within an agent will belong to the same community,

- Each of the *Request* messages will immediately generate a response message.

- Trap
  - Agents can asynchronously send *Traps* (similar to interrupts) to notify the NMS of some event which occurred on the managed device.

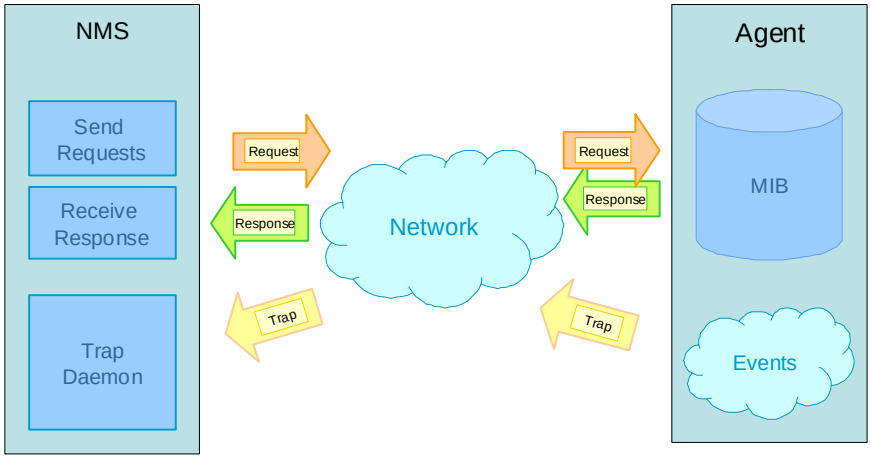

Figure D-2 SNMP architecture

E. Astronomy primer

E.1. Celestial coordinate systems

Several *Celestial Coordinate Systems* are used by astronomers to record the positions of objects in the sky. Some material in this section is an abridgement of the content in (4).

Both the *Equatorial* and *Horizon* coordinate systems are very similar to the well known *Terrestrial* coordinate system which uses longitude and latitude to specify a position on the earth. In order to understand how these coordinate systems work, the concept of the *celestial sphere* must be introduced.

E.1.1. Celestial sphere

The *celestial sphere* is a very large imaginary sphere which surrounds the earth. Like the earth, is has a north and south pole, and an equator. The Ecliptic is a circle on the plane of the earth's orbit. See Figure E-1.

A line constructed from the centre of the earth, through an observer on the surface will intersect the celestial sphere at a point called the Zenith. I.e. pointing at the Zenith is *always* looking straight up.

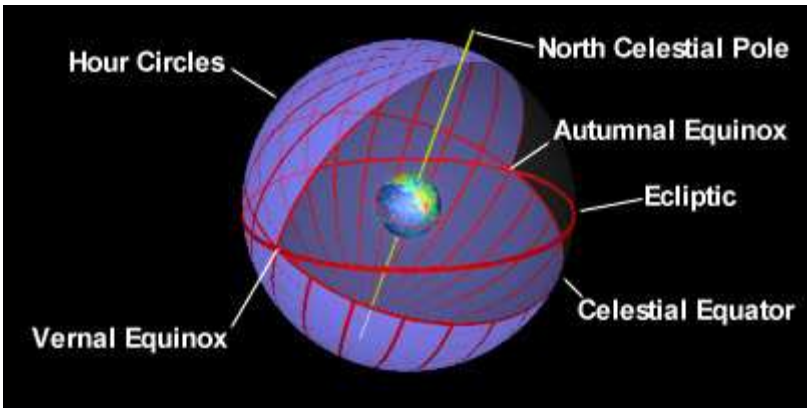

Figure E-1 Celestial sphere, sourced from (4).

E.1.2. The equatorial coordinate system

The *Equatorial Coordinate System* uses the hour lines and the celestial equator to specify the position of objects in the sky.

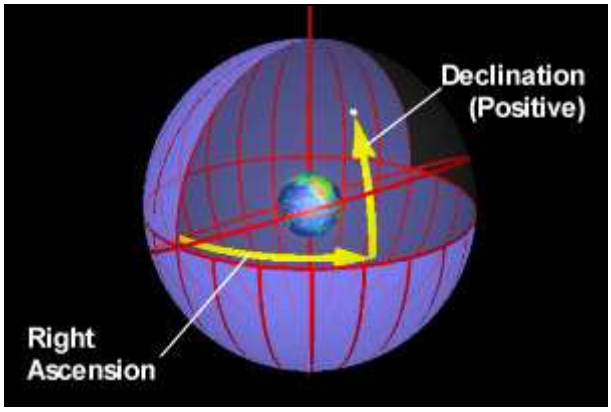

Figure E-2 Equatorial coordinates, sourced from (4).

Right Ascension is analogous to the *longitude* of the earth. It is essentially the angle formed from the vernal equinox, eastwards along the celestial equator, to the hour circle corresponding to the position of the object you wish to describe, as shown in Figure E-2. Right ascension is measured in hours, minutes and seconds[i].

Declination on the celestial sphere is analogous to *latitude* on the earth. That is, declination measures the angular distance either above or below the celestial equator (Figure E-2). It is measured in degrees, minutes, and seconds from +90 to -90 degrees. Such that 0 degrees specifies objects on the celestial equator, +90º indicates that an object is on the north celestial pole, and -90º on the south celestial pole

E.1.3. Coordinate epochs

The introduction of the celestial sphere provided a reference point for equatorial (and other astronomical coordinates).

Coordinates are based on the position of the earths axis and equator at specific times, or *epochs.* January 1, 1950 and 2000[ii] are the most common. Since the earths orientation is constantly changing with respect to the stars, these positions are tied to the coordinates of observed objects. Thus, the B1950 coordinate grid location is defined by the published positions of stars in the fourth Fundamental-Katalog, FK4, and the J2000 system is based on FK5 (7).

The J2000 system, currently in use by the APT, can provide an accuracy of approx 0.0005 arc seconds based on a reference set of about 400 celestial objects.

[i] From 0 to 24 hours.
[ii] Julian date 2451545.0

E.2. Astronomical times

E.2.1. Universal time

Universal time (UT) is the precise measurement of time used as the basis for civil time keeping (5). By definition, it is the *solar time* at the Greenwich meridian, also know as *Greenwich Mean Time* (GMT)[i]. Such that the sun passes directly over the Greenwich meridian at noon, UT.

Universal time is calculated in several ways:

- UT0 is the universal time calculated from astronomical observations.
- UT1 is UT0 adjusted to compensate for long term, uniform errors in the earths rotation (known as the *Chandler Wobble*).
- UT2 is UT1 adjusted to compensate for annual and semi-annual changes in the earths rotation rate.
- UTC, *Coordinated Universal Time* is calculated from TAI. UTC is identical to TAI except for the addition of *leap seconds* which are added to keep UTC accurate to within 0.9 seconds of UT1. Astronomers will typically quote UTC when recording observation data.

E.2.2. Atomic time

International Atomic Time (Temps Atomique International – TAI) is a time scale based on the SI unit for a second, defined as the duration of 9,192,631,770 cycles of radiation corresponding to the transition between two hyperfine levels of the ground state of caesium 133. TAI is a fixed scale and consequently does not compensate for irregularities in the earths rotation. It is maintained by approximately 200 atomic clocks worldwide.

E.2.3. Sidereal time

Sidereal time is used with the equatorial coordinate system. If a certain hour circle is on the celestial meridian, one sidereal hour later the next hour circle will be on the celestial meridian. The celestial sphere completes one rotation in relation to the earth every sidereal day (5). Thus, *Local Sidereal Time* (LST) is defined as the Right Ascension of the local *meridian*, or *hour circle,* as shown in Figure E-1.

E.2.4. Ephemeris time

Ephemeris Time (ET) was introduced in 1960 by astronomers to account for errors caused by variations in the earths rotation[i]. ET is currently one minute ahead of UT and gradually diverging.

[i] Now obseleted by UTC

E.2.5. Dynamical time

Dynamical Time, introduced in 1984 as a replacement for ephemeris time, more accurately defines a uniform astronomical time scale.

Terrestrial Dynamical Time (TDT) is a time scale tied to the earth, whereas *Barycentric Dynamical Time* (TDB) is used as a time reference for the barycentre[ii] of the solar system. When the difference of these two values (less than a few milliseconds) is considered negligible, TDT is simply referred to as TT. In most cases, TDT is considered to be equal to TAI plus 32.184 seconds.

E.2.6. Julian dates

The *Julian Day Number* (JDN) is a count of days elapsed since Greenwich mean noon on 1 January 4713 B.C., Julian proleptic calendar. The *Julian Date* (JD) is the Julian day number followed by the fraction of the day elapsed since the preceding noon.

The *Modified Julian Date* (MJD) is calculated as MJD = JD - 2400000.5. The 0.5 is included so that midnight, rather than noon, defines the change over point from one day to the next. MJD 0 started at 0000h GMT on Wednesday 17 Nov 1858 AD.

E.3. Gamma ray bursts

Gamma Ray Bursts (GRB's) are spectacular explosions of energy originating from distant galaxies. Lasting from 10 milliseconds to more than 15 minutes, these explosions release as much energy in 10 seconds, as a billion of our Suns. Despite the fact that GRB's occur quite frequently, approximately daily, very little is known of their nature or origin.

They were first discovered accidentally in the late 1960's by a team of American scientists[iii] commissioned by the military to monitor Soviet nuclear activity. Since then scientists have had difficulty studying them due to their short life span. The Gamma Ray Coordinate Network (GCN) was established to process incoming GRB data from satellites and coordinate observing.

The GCN is connected to a large network of satellites and spacecraft capable of detecting GRB's. When a GRB is detected, its RA and Dec is calculated and then broadcast to GCN subscribers within seconds, allowing remote observatories to obtain data while the GRB is still active.

The APT is ideal for observing the GRB's due to its wide field of view and fully automated operation.

E.4. Astronomical filters

Astronomical filters are special types of tinted lenses placed in front of the CCD to enhance the images acquired. Each filter only allows light from a limited range of wavelengths to pass through it. Astronomers exploit this behaviour to mask out specific parts of the spectrum, thus enhancing the image.

---

[i] These errors were first discovered in the 1930's
[ii] Centre of mass, similar to centre of gravity
[iii] led by Ray Klebesadel

The APT has the following filters available:

- Ultraviolet (R)
- Blue (B)
- Visible (V)
- Visible Red (VR)
- Infrared (I)
- Clear

E.5. Flat fielding

Flat Fielding refers to the process of calibrating the CCD to account for irregularities in the optics and errors within the CCD itself. A reference image is taken when the CCD is expected to return an image of constant intensity, such as the twilight sky. Any flaws in this reference image can be used to correct images obtained in the future.

This is not to be confused with the focal plane within the Telescope, which has been flattened using a field-flattening lens. Originally, images were obtained from the APT using photographic film which was placed in a spherical shaped collection area within the telescope. Because the CCD cannot be placed on a curved surface, the optics were modified with the addition of a lens to make the telescope focal plane flat out to a diameter of 5 degrees.

E.6. Cosmic rays

Cosmic Rays or *Cosmic Radiation,* in simple terms, refers to energised particles travelling in all directions throughout the universe. Very little is known of there origin. Optical astronomers are concerned with cosmic rays as they can affect images obtained with the CCD. If a cosmic ray strikes the CCD, the resulting image will falsely appear to show a bright star

To counteract this phenomenon, astronomers will typically take three images in succession, and compare the results to identify any spurious data caused by cosmic rays.

F. Selected code listings

F.1. Masterswitch module

F.1.1. Masterswitch.java

```
/**
 * $Id: Masterswitch.java,v 1.4 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch;

import java.util.Date;


/**
 * Description:
 *
 * <p>
 * This is an interface to the APC AP9212 Masterswitch
 * <a href="http://www.apc.com">www.apc.com</a>
 * <p>
 * It is a device that supplies 8 x 240V Power Outlets. These outlets can be
 * powered on and off remotely. Controlling these outlets is the main purpose
 * of the Masterswitch.java interface
 *
 * <p>
 *
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.4 $
 * @see apt.masterswitch.MasterswitchListener
 *
 */
public interface Masterswitch {


    /**
     * <p>
     * Getting this state from an outlet means that the outlet is curreny On
     * Setting an outlet to this state will switch the outlet On.
     */
    public static final String OUTLET_ON = "On";

    /**
     * <p>
     * Getting this state from an outlet means that the outlet is curreny Off
     * Setting an outlet to this state will switch the outlet Off.
     */
    public static final String OUTLET_OFF = "Off";


    /**
     * <p>
     * Setting an outlet this state will Reboot the outlet.
     */
    public static final String OUTLET_REBOOT = "Reboot";

    /**
     * This state can only be retrieved. It cannot be set.
     * <p>
     * An outlet will return this state when the apt.masterswitch.masterswitch cannot determine
       its state.
     * <p>
     * If this state is returned by any outlet, all devices powered by the Masterswitch
     * should be shut down. The Masterswitch's power should then be cycled
     * to clear this condition.
     */
    public static final String OUTLET_UNKNOWN = "Unknown";

    /**
     * <p>
     * Setting an outlet to this state will turn the outlet on
     * after the sPDUOutletPowerOnTime OID has elapsed. This option is not
```

```
     * valid for MasterSwitch firmware version 1.X.
     */
    public static final String OUTLET_ON_WITH_DELAY = "On with delay";


    /**
     * <p>
     * Setting an outlet to this state will turn the outlet off
     * after the sPDUOutletPowerOffTime OID has elapsed. This option is not
     * valid for MasterSwitch firmware version 1.X.
     */
    public static final String OUTLET_OFF_WITH_DELAY = "Off with delay";


    /**
     * <p>
     * Setting an outlet to this state will turn the outlet off
     * after the sPDUOutletPowerOffTime OID has elapsed, wait the
     * sPDUOutletRebootDuration OID time, then turn the outlet back on.
     * This option is not valid for MasterSwitch firmware version 1.X.
     */
    public static final String OUTLET_REBOOT_WITH_DELAY = "Reboot with delay";



    /**
     * <p>
     * An array of all the OUTLET_xxxx states. This can be used by GUI's to
     * populate menus.
     */
    public static final String[] ALL_STATES = {
        OUTLET_ON,
        OUTLET_OFF,
        OUTLET_REBOOT,
        OUTLET_UNKNOWN,
        OUTLET_ON_WITH_DELAY,
        OUTLET_OFF_WITH_DELAY,
        OUTLET_REBOOT_WITH_DELAY
    };

    /**
     * The number of outlets.
     * <p>
     * Note that outlets are referenced from 1 to NUM_OUTLETS
     */
    public final int NUM_OUTLETS = 8;

    /**
     * This call will Block until either it returns successfully, or an error occurs
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     * @param outlet The Masterswitch outlet. This is a number between 1 and 8
     * @return The String label corresponding to the outlet. Up to 20 Chars
     */
    public String getOutletName(int outlet)  throws MasterswitchException;

    /**
     * This call will Block until either it returns successfully, or an error occurs
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     * @param outlet The Masterswitch outlet. This is a number between 1 and 8
     * @return The String value corresponding to the outlets state. These values are defined in Masterswitch
          * @exception MasterswitchException
     */
    public String getOutletState(int outlet) throws MasterswitchException;

    /**
     * Set the outlets name
     * <p>
     * This call will Block until either it returns successfully, or an error occurs
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     * @param outlet The Masterswitch outlet. This is a number between 1 and 8
     * @param newName The new name for the specified outlet. Maximum of 20 chars
     * @return The String label corresponding to the outlet.
     * @exception MasterswitchException
     */
    public String setOutletName(int outlet, String newName)      throws MasterswitchException;

    /**
     * This call will Block until either it returns successfully, or an error occurs
     * <p>
     * @throws apt.masterswitch.MasterswitchException
```

```
     * @param outlet The Masterswitch outlet. This is a number between 1 and 8
     * @return The String value corresponding to the outlets state. These values are defined in Masterswitch
     * @exception MasterswitchException
     */
    public String setOutletState(int outlet, String outletState) throws MasterswitchException;



    /**
     * The hardware revision of the PDU (Power Distribution Unit). This value
     * is set at the factory.
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     */
    public String getHardwareRevision() throws MasterswitchException;


    /**
     *  An 8 byte ID string identifying the PDU firmware revision.
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     */
    public String getFirmwareRevision() throws MasterswitchException;

    /**
     *  The date when the PDU was manufactured in mm/dd/yy format.
     *  This value is set at the factory. The year 2000 will be
     *  represented by 00.
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     */
    public String getDateOfManufacture() throws MasterswitchException;

    /**
     *  A 10-character string identifying the model number of
     *  the PDU internal. This value is set at the factory.
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     */
    public String getModelNumber() throws MasterswitchException;

    /**
     * A 12-character string identifying the serial number of
     * the PDU internal microprocessor. This value is set at
     * the factory.
     * <p>
     * @throws apt.masterswitch.MasterswitchException
     */
    public String getSerialNumber() throws MasterswitchException;

    /**
     * Register the {@link apt.masterswitch.MasterswitchListener} object so
     * that it receives events.
     * <p>
     * @param listener   The object to receive events
     * @see apt.masterswitch.MasterswitchListener
     */
    public void addMasterswitchListener( MasterswitchListener listener);

    /**
     * Remove the {@link apt.masterswitch.MasterswitchListener} so that it no longer receives
     * events
     * <p>
     * @param listener   The object to no longer receive events
     * @see apt.masterswitch.MasterswitchListener
     */
    public void removeMasterswitchListener( MasterswitchListener listener );


}
```

F.1.2. AbstractMasterswitch.java

```java
/**
 * $Id: AbstractMasterswitch.java,v 1.2 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch;


import java.util.ArrayList;
import java.util.List;
import java.util.Iterator;
import java.util.Collections;
import java.util.logging.Logger;
import java.util.logging.Level;


/**
 * Description:
 * <p>
 * This implements some of the common tasks required by
 * full Masterswitch implementations. Such as MasterswitchListener
 * event management code
 * <p>
 *
 * @see apt.masterswitch.MasterswitchListener
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.2 $
 *
 *
*/
public abstract class AbstractMasterswitch implements Masterswitch {

    private List listeners;
    private final Logger logger = Logger.getLogger( getClass().getName() );

    public AbstractMasterswitch() {

        logger.log(Level.INFO,"Initialising Masterswitch");
        listeners = Collections.synchronizedList( new ArrayList(5) );

    }

    protected void checkOutlet(int outlet) throws IllegalArgumentException {
        if( outlet < 1 || outlet > NUM_OUTLETS ) {
            throw new IllegalArgumentException("Invalid outlet number: "+outlet);
        }
    }

    protected void fireOutletStateChanged(int outlet, String newState) {
        Iterator i = listeners.iterator();
        while (i.hasNext()) {
            MasterswitchListener listener = (MasterswitchListener) i.next();
            listener.outletStateChanged(outlet,newState);
        }

    }

    protected void fireOutletNameChanged(int outlet, String newName) {
        Iterator i = listeners.iterator();
        while (i.hasNext()) {
            MasterswitchListener listener = (MasterswitchListener) i.next();
            listener.outletStateChanged(outlet,newName);
        }

    }
    protected void fireStateChanged() {
        Iterator i = listeners.iterator();
        while (i.hasNext()) {
            MasterswitchListener listener = (MasterswitchListener) i.next();
            listener.stateChanged();
        }

    }



    public void addMasterswitchListener( MasterswitchListener listener) {

        if( listener == null ) {
            throw new NullPointerException("Cannot addMasterswitchListener(null)");
        }
```

```
        if( listener instanceof MasterswitchListener ) {
            if( listeners.contains(listener) ) {
                logger.log(Level.INFO, "Cannot add MasterswitchListener, it has already been added" );
            } else {
                listeners.add( listener );
            }
        } else {
            logger.log(Level.WARNING, "Cannot add MasterswitchListener, it is not of the correct instance
type");
        }
    }


    public void removeMasterswitchListener( MasterswitchListener listener ) {
        listeners.remove(listener);
    }
}
```

F.1.3. MasterswitchListener.java

```
/**
 * $Id: MasterswitchListener.java,v 1.2 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch;


/**
 * Description:
 * <p>
 * The listener interface for receiving Masterswitch Events.
 * <p>
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.2 $
 * @see apt.masterswitch.Masterswitch
 *
*/
public interface MasterswitchListener {

    /**
     * The outlet has changed to newState
     * <p>
     * @param outlet        The outlet number from 1 to {@link apt.masterswitch.Masterswitch#NUM_OUTLETS
NUM_OUTLETS}
     * @param newState     The new state of the specified outlet. This must be found in {@link
apt.masterswitch.Masterswitch#ALL_STATES ALL_STATES}
     */
    public void outletStateChanged(int outlet, String newState);

    /**
     * The outlet has been renamed to newName
     * <p>
     * @param outlet    The outlet number from 1 to {@link apt.masterswitch.Masterswitch#NUM_OUTLETS
NUM_OUTLETS}
     * @param newName   The new String label for the specified outlet
     */
    public void outletNameChanged(int outlet, String newName);

    /**
     * Something has changed on the masterswitch, but we are not sure
     * what. This event should typically be used to refresh the masterswitch
     * status.
     * <p>
     */
    public void stateChanged();
}
```

F.1.4. MasterswitchException.java

```
/**
 * $Id: MasterswitchException.java,v 1.2 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch;

/**
 * Description:
 * <p>
 * The exception object used to encapsulate any errors that can be
 * encountered by the operation of the masterswitch.
 * <p>
 * Specific details of the error condition are contained in the message
 * string and/or by a Throwable object.
 * <p>
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.2 $
 *
*/
public class MasterswitchException  extends Exception {

    public MasterswitchException(String message) {
        super(message);
    }

    public MasterswitchException(Throwable cause) {
        super(cause);
    }

    public MasterswitchException(String message, Throwable cause) {
        super(message, cause);
    }
}
```

F.1.5. SNMPMasterswitch.java

```
/**
 * $Id: SNMPMasterswitch.java,v 1.6 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch.snmp;



import org.opennms.protocols.snmp.*;

import java.util.*;
import java.util.logging.Logger;
import java.util.logging.Level;
import java.net.InetAddress;
import java.net.UnknownHostException;
import java.net.SocketException;
import java.io.FileNotFoundException;

import pt.ipb.agentapi.mibs.MibModule;
import pt.ipb.agentapi.mibs.MibException;
import pt.ipb.agentapi.OID;
import apt.masterswitch.AbstractMasterswitch;
import apt.masterswitch.Masterswitch;
import apt.masterswitch.MasterswitchException;



/**
 * Description:
 * <p>
 * An implementation of {@link apt.masterswitch.Masterswitch} using the SNMP
 * interface to the APC Masterswitch.
 * <p>
 * SNMP Transport is handled using the <a href="http://www.opennms.org">opennms joesnmp stack</a>
 * <p>
 * Control of the device is achived by sending SNMP Messages as Datagram Packets to the
 * <i>Management Interface Board</i> built into the Masterswitch Device
 * <p>
 * Changes to status information on the masterswitch are detected by listening
 * to events from a {@link apt.masterswitch.snmp.SnmpTrapDaemon}
 *
 *
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.6 $
 * @see apt.masterswitch.snmp.SnmpTrapListener
*/
public class SNMPMasterswitch extends AbstractMasterswitch implements SnmpHandler, SnmpTrapListener {



    // These are the values needed to populate the snmp packets
    private static final int SNMP_OUTLET_ON = 1;
    private static final int SNMP_OUTLET_OFF = 2;
    private static final int SNMP_OUTLET_REBOOT = 3;
    private static final int SNMP_OUTLET_UNKNOWN = 4; // this value cannot be set. If it is read, the
apt.masterswitch.masterswitch must be power cycled.
    private static final int SNMP_OUTLET_ON_WITH_DELAY = 5;
    private static final int SNMP_OUTLET_OFF_WITH_DELAY = 6;
    private static final int SNMP_OUTLET_REBOOT_WITH_DELAY = 7;


    private static final String MASTERSWITCH_IP = "150.203.153.9";
    private static final String SNMP_COMM_READ  = "public";
    private static final String SNMP_COMM_WRITE = "private";

    private static final String MIB_FILENAME = "./config/snmp/POWERNET.MIB";



    private static SNMPMasterswitch singletonInstance;


    //sPDUOutletControlTable
    private static final String sPDUOutletPending = "sPDUOutletPending";
    private static final String sPDUOutletCtl     = "sPDUOutletCtl";
```

```
    private static final String sPDUOutletCtlName = "sPDUOutletCtlName"; // This is similar to sPDUOutletName,
except only sPDUOutletName can be SET

    // sPDUOutletConfig Table
    private static final String sPDUOutletPowerOnTime    = "sPDUOutletPowerOnTime";
    private static final String sPDUOutletName           = "sPDUOutletName";
    private static final String sPDUOutletPowerOffTime   = "sPDUOutletPowerOffTime";
    private static final String sPDUOutletRebootDuration = "sPDUOutletRebootDuration";

    private static final String sPDUIdentHardwareRev       = "sPDUIdentHardwareRev";
    private static final String sPDUIdentFirmwareRev       = "sPDUIdentFirmwareRev";
    private static final String sPDUIdentDateOfManufacture = "sPDUIdentDateOfManufacture";
    private static final String sPDUIdentModelNumber       = "sPDUIdentModelNumber";
    private static final String sPDUIdentSerialNumber      = "sPDUIdentSerialNumber";


    private final Logger log = Logger.getLogger( getClass().getName() );



    /**
     * There is only one Masterswitch object allowed to be created in memory at
     * any one time.
     *
     * @return The singleton instance of this device
     */
    public synchronized static Masterswitch getInstance() throws MasterswitchException {

        if( singletonInstance == null ) {
            singletonInstance = new SNMPMasterswitch();
        }
        return singletonInstance;
    }


    private boolean loaded;
    private boolean watcherRunning;
    private java.util.Timer timer;

    private SnmpSession session;
    private MibModule mibModule;


    private SnmpSyntax value;
    private boolean waitingForResponse;

    private SNMPMasterswitch() throws MasterswitchException {
        loaded = false;
        load();
    }

    private synchronized void load() throws MasterswitchException {

        watcherRunning = false;
        waitingForResponse = false;

        InetAddress addr = null;
        try {
            addr = InetAddress.getByName(MASTERSWITCH_IP);
        } catch (UnknownHostException e) {
            log.log(Level.SEVERE, "The address \""+MASTERSWITCH_IP+"\" is unknown",e);
            throw new MasterswitchException("Cannot initialise Masterswitch",e);
        }

        SnmpParameters params = new SnmpParameters(SNMP_COMM_READ, SNMP_COMM_WRITE);
        params.setVersion(SnmpSMI.SNMPV1 );

        try {
            session = new SnmpSession( addr,params);
        } catch (SocketException e) {
            log.log(Level.SEVERE, "Cannot create SNMP session with Masterswitch",e);
            throw new MasterswitchException("Cannot initialise Masterswitch",e);
        }

        session.setDefaultHandler(this);



        // Load MIB file
        try {
            mibModule = MibModule.load( MIB_FILENAME );
        } catch (MibException e) {
            log.log(Level.WARNING, "Cannot load \""+MIB_FILENAME+"\", unexpected MibException ",e);
```

```
            throw new MasterswitchException("Cannot initialise Masterswitch",e);
        } catch (FileNotFoundException e) {
            log.log(Level.WARNING, "Cannot load \""+MIB_FILENAME+"\", File not found ",e);
            throw new MasterswitchException("Cannot initialise Masterswitch",e);
        }


        timer = new Timer(true);

        // Initialise Trap Listener on port 162
        log.log(Level.INFO, "Attempting to start SNMP Trap Daemon for event notification...");


        // Java Snmp Trap Daemon
        // SnmpTrapDaemon trapd = SnmpTrapDaemonImpl.getInstance();
        SnmpTrapDaemon trapd = LinuxSnmpTrapDaemonImpl.instance;
        trapd.addSnmpTrapListener(this);
        trapd.start();

        // If the trapd cannot be started it will fire a snmpTrapDaemonStopped()
        // event. This SNMPMasterswitch will then use a polling technique for
        // monitoring state changes on the masterswitch device.



        // The apt.masterswitch.masterswitch object has successfully been loaded
        loaded = true;
        log.log(Level.INFO, "Masterswitch successfully loaded");



    }


    private boolean isLoaded() {
        return loaded;
    }

    private synchronized void unload()  {

        if( watcherRunning ) {
            timer.cancel();
            watcherRunning = false;
        }

        try {

            session.close();
            // Shutdown the Trap Listener on port 162, if its running
            SnmpTrapDaemon trapd = SnmpTrapDaemonImpl.getInstance();
            // remove listener before stopping because
            // trapDStopped event will cause the SNMPMasterswitch to
            // start polling the masterswitch..
            trapd.removeSnmpTrapListener(this);
            trapd.stop();

        } catch (Exception e1) {
            log.log(Level.WARNING, "Could not close the snmp session while unloading");
        }

        session = null;
        mibModule = null;
        value = null;
        timer = null;
        loaded = false;


        log.log(Level.INFO, "Masterswitch successfully unloaded");

    }


    private SnmpSyntax doSNMPGet( String oid ) throws MasterswitchException {

        SnmpVarBind[]  vblist = { new SnmpVarBind(oid) };
        SnmpPduRequest pdu = new SnmpPduRequest(SnmpPduPacket.GET, vblist);

        log.log(Level.FINE, "SNMP Get OID = "+oid);

        return doSNMP( pdu );
    }
```

```
    private SnmpSyntax doSNMPSet( String oid, SnmpSyntax data ) throws MasterswitchException  {

        SnmpVarBind[]  vblist = { new SnmpVarBind(oid,data) };
        SnmpPduRequest pdu = new SnmpPduRequest(SnmpPduPacket.SET, vblist);

        log.log(Level.FINE, "SNMP Set OID = "+oid+": " + data);

        return doSNMP( pdu );

    }

    private SnmpSyntax doSNMP( SnmpPduRequest pdu )  throws MasterswitchException  {


        pdu.setRequestId(SnmpPduPacket.nextSequence());

        // get a lock on the session object,
        // this ensures that another pdu cannot be sent until
        // the previous one has been received.
        synchronized(session) {
            try {
                waitingForResponse = true;
                session.send(pdu);
                while( waitingForResponse ) {
                    session.wait();
                }
                // This should be woken up by an SnmpHandlerMethod which has
                // setup the "value" variable which contains the result of
                // the SNMP request, Also the thread which received the response
                // must waitingForResponse = false

            } catch (Exception e ) {
                e.printStackTrace();
            }
        }

        if( value == null  ) {
            // There was an error
            log.log(Level.INFO, "SNMP returned a Null value");
            throw new MasterswitchException("An SNMP error prevented communication with the Masterswitch");
        }

        return value;
    }



    public synchronized String getOutletName(int outlet)  throws MasterswitchException {
        checkOutlet(outlet);

        String oid = mibModule.getNode(sPDUOutletName).getOID().toJavaValue() + "."+outlet;

        String outletName = doSNMPGet(oid).toString();
        return outletName;
    }

    public synchronized String getOutletState(int outlet) throws MasterswitchException {
        checkOutlet(outlet);

        String oid = mibModule.getNode(sPDUOutletCtl).getOID().toJavaValue() + "."+outlet;

        SnmpInt32 outletState = (SnmpInt32)doSNMPGet(oid);
        int outletSnmpState = outletState.getValue();

        String outletStateStr = outletIntToOutletStr( outletSnmpState );
        return outletStateStr;


    }


    /**
     *  This converts an outlet state as an integer constant defined in
     *  {@link apt.masterswitch.snmp.SNMPMasterswitch } to an equivalent
     *  String constant as defined
     *  in {@link apt.masterswitch.Masterswitch }
     *  <p>
     *  Note: String constants are used to make error messages more readable.
     */
    private String outletIntToOutletStr(int outletInt ) {

        if( outletInt ==  SNMP_OUTLET_ON ) {
            return OUTLET_ON;
```

```
        } else if(outletInt == SNMP_OUTLET_OFF  ) {
            return OUTLET_OFF;
        } else if(outletInt == SNMP_OUTLET_REBOOT  ) {
            return OUTLET_REBOOT;
        } else if(outletInt == SNMP_OUTLET_UNKNOWN  ) {
            return OUTLET_UNKNOWN;
        } else if(outletInt == SNMP_OUTLET_ON_WITH_DELAY  ) {
            return OUTLET_ON_WITH_DELAY;
        } else if(outletInt == SNMP_OUTLET_OFF_WITH_DELAY  ) {
            return OUTLET_OFF_WITH_DELAY;
        } else if(outletInt == SNMP_OUTLET_REBOOT_WITH_DELAY  ) {
            return OUTLET_REBOOT_WITH_DELAY;
        } else {
            log.log(Level.WARNING, "Undefined outlet state: "+outletInt);
            return "UNDEFINED";
        }
    }



    public synchronized String setOutletName(int outlet, String newName)  throws MasterswitchException {
        checkOutlet(outlet);
        if( newName == null ) {
            throw new NullPointerException("Must specify a newName");
        }

        String oid = mibModule.getNode(sPDUOutletName).getOID().toJavaValue() + "."+outlet;
        log.log(Level.FINE, "OID = "+oid);


        // Try to set the value
        doSNMPSet(oid, new SnmpOctetString( newName.getBytes() ) );

        // Get the value to check that the set was successful
        // --> it will fail if another user is logged in
        String returnVal  = (doSNMPGet(oid )).toString();

        if( ! returnVal.equals( newName) ) {
            log.log(Level.WARNING, "Request ignored by apt.masterswitch.masterswitch. Another user is probably
logged in");
        }


        return returnVal;


    }

    public synchronized String setOutletState(int outlet, String outletState) throws MasterswitchException {
        checkOutlet(outlet);

        int snmpState;

        if( outletState.equals( OUTLET_ON ) ) {
            snmpState = SNMP_OUTLET_ON;
        } else if( outletState.equals( OUTLET_OFF ) ){
            snmpState = SNMP_OUTLET_OFF;
        } else if( outletState.equals( OUTLET_REBOOT ) ){
            snmpState = SNMP_OUTLET_REBOOT;
        } else if( outletState.equals( OUTLET_UNKNOWN ) ) {
            snmpState = SNMP_OUTLET_UNKNOWN;
        } else if( outletState.equals( OUTLET_ON_WITH_DELAY ) ) {
            snmpState = SNMP_OUTLET_ON_WITH_DELAY;
        } else if( outletState.equals( OUTLET_OFF_WITH_DELAY ) ) {
            snmpState = SNMP_OUTLET_OFF_WITH_DELAY;
        } else if( outletState.equals( OUTLET_REBOOT_WITH_DELAY ) ) {
            snmpState = SNMP_OUTLET_REBOOT_WITH_DELAY;
        } else  {
            // The user has tried to set the outlet to an undefined state
            throw new MasterswitchException("Cannot set outlet to state \""+outletState+"\", it is undefined");
        }

        String oid = mibModule.getNode(sPDUOutletCtl).getOID().toJavaValue() + "."+outlet;
        log.log(Level.FINE, "OID = "+oid);

        // Try to set the value
        doSNMPSet(oid, new SnmpInt32(snmpState ));

        // Get the value to check that it was set
        SnmpInt32 returnedVal = (SnmpInt32)doSNMPGet(oid);


        if( returnedVal.getValue() != snmpState ) {
```

```
            log.log(Level.WARNING, "Request ignored by apt.masterswitch.masterswitch. Another user is probably
logged in");
        }

        String returnedState = outletIntToOutletStr(returnedVal.getValue());
        return returnedState;


    }

    /**
     * The hardware revision of the PDU (Power Distribution Unit). This value
     * is set at the factory.
     */
    public synchronized String getHardwareRevision()  throws MasterswitchException{

        String oid = mibModule.getNode(sPDUIdentHardwareRev).getOID().toJavaValue().toString();

        String hardwareRev = doSNMPGet(oid).toString();
        return hardwareRev;
    }

    /**
     *  An 8 byte ID string identifying the PDU firmware revision.
     */
    public synchronized String getFirmwareRevision() throws MasterswitchException {
        String oid = mibModule.getNode(sPDUIdentFirmwareRev).getOID().toJavaValue().toString();

        String firmwareRev = doSNMPGet(oid).toString();
        return firmwareRev;
    }

    /**
     *  The date when the PDU was manufactured in mm/dd/yy format.
     *  This value is set at the factory. The year 2000 will be
     *  represented by 00.
     */
    public synchronized String getDateOfManufacture() throws MasterswitchException {
        String oid = mibModule.getNode(sPDUIdentDateOfManufacture).getOID().toJavaValue().toString();

        String dateOfMF = doSNMPGet(oid).toString();
        return dateOfMF;
    }

    /**
     *  A 10-character string identifying the model number of
     *  the PDU internal. This value is set at the factory.
     */
    public synchronized String getModelNumber() throws MasterswitchException {
        String oid = mibModule.getNode(sPDUIdentModelNumber).getOID().toJavaValue().toString();

        String modelNum = doSNMPGet(oid).toString();
        return modelNum;
    }

    /**
     *  A 12-character string identifying the serial number of
     * the PDU internal microprocessor. This value is set at
     * the factory.
     */
    public synchronized String getSerialNumber()  throws MasterswitchException{
        String oid = mibModule.getNode(sPDUIdentSerialNumber).getOID().toJavaValue().toString();

        String serialNum = doSNMPGet(oid).toString();
        return serialNum;
    }
    /**
     *
     *   SnmpHandler interface
     *
     */

    /**
     * <P>This method is invoked when a pdu is successfully
     * returned from the peer agent. The command argument
     * is recovered from the received pdu.</P>
     * <p>
     * @param session The SNMP session
     * @param command The PDU command
     * @param pdu               The SNMP pdu
     *
     */
    public void snmpReceivedPdu(SnmpSession session,
```

```
                                int command,
                                SnmpPduPacket pdu) {


        SnmpPduRequest req = null;
                    if(pdu instanceof SnmpPduRequest) {
                                req = (SnmpPduRequest)pdu;
                //req.getErrorStatus()
                    }

                    if(pdu.getCommand() != SnmpPduPacket.RESPONSE) {
                                log.log( Level.WARNING, "Error: Received non-response command " +
pdu.getCommand());
                value = null;
                waitingForResponse = false;
                synchronized(session)  {
                                            session.notifyAll();
                                }
                                return;
                    }

                    // Passed the checks so lets get the first varbind and
                    // print out it's value
                    SnmpVarBind vb = pdu.getVarBindAt(0);
            //log.log(Level.FINE, mibModule.getNode( vb.getName().toString() )+":"+vb.getValue() );
            log.log(Level.FINE, "Received "+":"+vb.getValue() );

            value = vb.getValue();
            waitingForResponse = false;

            // Wake up the calling thread so it can return a value
            synchronized(session) {
                session.notifyAll();
            }


    }

    /**
     * <p>
     * This method is invoked when an agent fails to respond
     * in the required time. This method will only be invoked
     * if the total retries exceed the number defined by the
     * session.
     * <p>
     *
     * @param session The SNMP Session
     * @param pdu                The PDU object that timed out
     *
     */
    public void snmpTimeoutError(SnmpSession session, SnmpSyntax pdu) {


                    log.log(Level.WARNING, "The session timed out trying to communicate with the remote
host");

            value = null;
            waitingForResponse = false;

            // Wake up the blocking request thread
                    synchronized(session) {
                                session.notifyAll();
                    }

    }

    /**
     * <p>
     * This method is invoked when an internal error occurs
     * for the session. To determine the exact error the
     * err parameter should be compared with all the error
     * conditions defined in the SnmpSession class.
     * </p>
     *
     * @param session The SNMP session in question
     * @param err                The error that occured
     * @param pdu                The PDU object that caused the error
     *
     */
    public void snmpInternalError(SnmpSession session,
                                  int err,
                                  SnmpSyntax pdu) {
```

```
        log.log(Level.WARNING, "An unexpected error occured with the SNMP Session");
        log.log(Level.WARNING, "The error code is " + err);


        value = null;
        waitingForResponse = false;

        // Wake up the blocking thread
        synchronized(session) {
                                session.notifyAll();
                    }
    }


    public void snmpTrapDaemonStarted() {
        log.log(Level.INFO, "Listening to SNMP traps...");

        if( watcherRunning ) {
            timer.cancel();
            watcherRunning = false;
        }

    }

    public void snmpTrapDaemonStopped() {
        log.log(Level.INFO, "Not listening to SNMP traps");
        log.log(Level.INFO, "Periodically polling Masterswitch for event notification");

        timer.scheduleAtFixedRate( new MasterswitchWatcher(), 3000,3000 );
        watcherRunning = true;
    }

    public void snmpTrapReceived() {
        /**
         * This simple implementation just says 'something'
         * changed whenever we receive a trap.
         *
         * It could be improved by analysing the trap to see
         * exactly what happened and generate a more specific event
         */
        fireStateChanged();
    }

    /**
     *
     *  The run method of this class will be periodically
     *  called to notify masterswitchListeners if anything has changed.
     *
     */
    private class MasterswitchWatcher extends TimerTask {


        private String[] outletNames;
        private String[] outletStates;

        public MasterswitchWatcher() {
            outletNames = new String[8];
            outletStates = new String[8];

            // Populate the cached values
            try {
                for (int i = 0; i < outletNames.length; i++) {
                    outletNames[i] = getOutletName(i+1);
                }
                for (int i = 0; i < outletStates.length; i++) {
                    outletStates[i] = getOutletState(i+1);
                }
            } catch (MasterswitchException e) {
                log.log(Level.WARNING, "Problem while checking if the Masterswitch has changed state",e);
            }

        }

         public void run() {

             log.log( Level.INFO, "Checking Masterswitch for changes...");
             try {
                 for (int i = 0; i < outletNames.length; i++) {
                     String currName = getOutletName(i+1);
                     if(  !outletNames[i].equals( currName ) ) {
                           outletNames[i] = currName;
```

```
                        System.out.println("fireOutletNameChanged("+((int)(i+1))+", "+currName+");");
                        fireOutletNameChanged(i+1, currName);
                    }
                }

                for (int i = 0; i < outletStates.length; i++) {
                    String currState = getOutletState(i+1);
                    if(  !outletStates[i].equals( currState) ) {
                        outletStates[i] = currState;
                        System.out.println("fireOutletStateChanged("+((int)(i+1))+", "+currState+");");
                        fireOutletStateChanged(i+1, currState);
                    }
                }
            } catch (MasterswitchException e) {
                log.log(Level.WARNING, "Problem while checking if the Masterswitch has changed state",e);
            }

        }
    }

}
```

F.1.6. SnmpTrapDaemon.java

```
/**
 * $Id: SnmpTrapDaemon.java,v 1.3 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch.snmp;


/**
 * Description:
 * <p>
 * This interface specifies the methods required for an
 * SNMP TrapDaemon.
 * <p> An SNMP Trap Daemon will listen on UDP port 162 for SNMP traps, generating
 * an event to notify SnmpTrapListeners that an event has occurred.
 * <p>
 * This interfaces it used by {@link apt.masterswitch.snmp.SNMPMasterswitch } to
 * detect state changes on the masterswitch device.
 *
 * @see apt.masterswitch.snmp.SnmpTrapListener
 * @see apt.masterswitch.Masterswitch
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.3 $
 *
*/
public interface SnmpTrapDaemon {

    /**
     *  Start listening to SNMP traps
     */
    public void start();

    /**
     * Stop listening to SNMP Traps
     */
    public void stop();


    /**
     * Register the {@link apt.masterswitch.snmp.SnmpTrapListener} object
     * so that it receives events.
     * <p>
     * @param listener    The object to receive events
     * @see apt.masterswitch.snmp.SnmpTrapListener
     */
    public void addSnmpTrapListener(SnmpTrapListener listener);

    /**
     * Removes the {@link apt.masterswitch.snmp.SnmpTrapListener} object so it no longer
     * receives events.
     * <p>
     * @param listener   The object to no longer receive events
     * @see apt.masterswitch.snmp.SnmpTrapListener
     */
    public void removeSnmpTrapListener(SnmpTrapListener listener);


}
```

F.1.7. AbstractSnmpTrapDaemon.java

```
/**
 * $Id: AbstractSnmpTrapDaemon.java,v 1.3 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch.snmp;

import java.util.List;
import java.util.ArrayList;
import java.util.Iterator;
import java.util.logging.Level;
import java.util.logging.Logger;


/**
 * Description:
 * <p>
 * This implements some of the common tasks required by
 * full SnmpTrapDaemon implementations.
 * <p>
 * Specifically SnmpTrapListener event management code
 * <p>
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.3 $

 *
*/
public abstract class AbstractSnmpTrapDaemon implements SnmpTrapDaemon {


    private List listeners;
    protected final Logger logger = Logger.getLogger( getClass().getName() );

    public AbstractSnmpTrapDaemon() {
        listeners = new ArrayList(5);
    }

    /**
     * Register the {@link apt.masterswitch.snmp.SnmpTrapListener} object
     * so that it receives events.
     * <p>
     * @param listener    The object to receive events
     * @see apt.masterswitch.snmp.SnmpTrapListener
     */
    public void addSnmpTrapListener(SnmpTrapListener listener) {
        if( listener == null ) {
            throw new NullPointerException("Cannot addSnmpTrapListener(null)");
        }

        if( listener instanceof SnmpTrapListener ) {
            if( listeners.contains(listener) ) {
                logger.log(Level.INFO, "Cannot add SnmpTrapListener, it has already been added" );
            } else {
                listeners.add( listener );
            }
        } else {
            logger.log(Level.WARNING, "Cannot add SnmpTrapListener, it is not of the correct instance type");
        }
    }


    /**
     * Removes the {@link apt.masterswitch.snmp.SnmpTrapListener} object so it no longer
     * receives events.
     * <p>
     * @param listener   The object to no longer receive events
     * @see apt.masterswitch.snmp.SnmpTrapListener
     */
    public void removeSnmpTrapListener(SnmpTrapListener listener) {
        listeners.remove(listener); // if "listener" is not in the list
                                    // the List collection will handle it
    }
```

```
    protected void fireSnmpTrapDaemonStarted() {
        Iterator i = listeners.iterator();
        while (i.hasNext()) {
            SnmpTrapListener listener = (SnmpTrapListener) i.next();
            listener.snmpTrapDaemonStarted();
        }

    }
    protected void fireSnmpTrapDaemonStopped() {
        Iterator i = listeners.iterator();
        while (i.hasNext()) {
            SnmpTrapListener listener = (SnmpTrapListener) i.next();
            listener.snmpTrapDaemonStopped();
        }
    }


    protected void fireSnmpTrapReceived() {
        Iterator i = listeners.iterator();
        while (i.hasNext()) {
            SnmpTrapListener listener = (SnmpTrapListener) i.next();
            listener.snmpTrapReceived();
        }
    }


}
```

F.1.8. SnmpTrapDaemonImpl.java

```
/**
 * $Id: SnmpTrapDaemonImpl.java,v 1.4 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch.snmp;

import org.opennms.protocols.snmp.*;

import java.util.logging.Level;
import java.util.logging.Logger;
import java.net.InetAddress;
import java.net.SocketException;


/**
 * Description:
 *
 * <p>
 * This is an implementation of the SnmpTrapListener interface
 * primarily based on the org.opennms.protocols.snmp.SnmpTrapHandler
 * interface
 * <p>
 * Using the tools from org.opennms.protocols.snmp, a thead is bound to
 * UDP port 162 to listen for snmp traps.
 * <p>
 * Root permissions are required for this TrapDaemon to start()
 * <p>
 * @see apt.masterswitch.snmp.SnmpTrapListener
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.4 $
 *
*/
public final class SnmpTrapDaemonImpl extends AbstractSnmpTrapDaemon implements SnmpTrapHandler{


    private final Logger logger = Logger.getLogger( getClass().getName() );
    private static final SnmpTrapDaemon singletonInstance = new SnmpTrapDaemonImpl();

    private SnmpTrapSession trapSession;

    private SnmpTrapDaemonImpl() {

    }

    public static SnmpTrapDaemon getInstance() { return singletonInstance; }


    public static void main(String[] args) {

        System.out.println("Starting SNMP Trap Daemon...");
        SnmpTrapDaemon trapd = SnmpTrapDaemonImpl.getInstance();
        trapd.start();
        System.out.println("SNMP Trap Daemon Running...");

        /*
        try {
            Thread.sleep(5000);
        } catch (InterruptedException e) {
        }

        trapd.stop();
        */

    }


    /**
     * Start listening to SNMP Traps by
     * creating a org.opennms.protocols.snmp.SnmpTrapSession
     * <p>
     */
    public void start(){

        try {
            trapSession = new SnmpTrapSession(this);
```

```
            logger.log( Level.INFO, "Java SnmpTrapDaemon Started");
            fireSnmpTrapDaemonStarted();
        } catch (SocketException e) {
            logger.log( Level.WARNING, "Could not initialise SnmpTrapSession");
            logger.log( Level.WARNING, "Check the permissions for UDP port 162, you may have to run this code
as root",e);
            fireSnmpTrapDaemonStopped();
        }


    }


    /**
     * Stop listening to SNMP Traps by closing the
     * org.opennms.protocols.snmp.SnmpTrapSession
     */
    public void stop() {

        if( trapSession != null ) {
            synchronized(trapSession) {
                if( trapSession.isClosed() ) {
                    logger.log( Level.INFO,"Tried to stop SnmpTrapDaemon, but it is not running");
                } else {
                    trapSession.close();
                    trapSession = null;
                    logger.log( Level.INFO, "Java SnmpTrapDaemon Stopped");
                    fireSnmpTrapDaemonStopped();
                }

            }
        }


    }


/**
            * <P>This method is defined to handle SNMPv2 traps
            * that are received by the session. The parameters
            * allow teh handler to determine the host, port, and
            * community string of the received PDU</P>
            *
            * @param session     The SNMP session
            * @param agent                 The remote sender
            * @param port                  The remote senders port
            * @param community   The community string
            * @param pdu                   The SNMP pdu
            *
            */
           public void snmpReceivedTrap(SnmpTrapSession          session,
                                        InetAddress     agent,
                                        int             port,
                                        SnmpOctetString community,
                                        SnmpPduPacket   pdu) {

        logger.log( Level.WARNING, "Received SNMP V2 Trap from "+ agent + " on port "+ port );
                    logger.log( Level.FINE, "V2 Trap PDU command         " + pdu.getCommand());
                    logger.log( Level.FINE, "V2 Trap PDU ID              " + pdu.getRequestId());
                    logger.log( Level.FINE, "V2 Trap PDU Length          " + pdu.getLength());

                    if(pdu instanceof SnmpPduRequest)
                    {
                        logger.log( Level.FINE, "V2 Trap PDU Error Status    " +
                           ((SnmpPduRequest)pdu).getErrorStatus());
                        logger.log( Level.FINE, "V2 Trap PDU Error Index     " +
                           ((SnmpPduRequest)pdu).getErrorIndex());
                    }

                    int k = pdu.getLength();
                    for (int i = 0; i < k ; i++ )  {
                              SnmpVarBind vb = pdu.getVarBindAt(i);
                              logger.log( Level.FINE, "Varbind[" + i + "] := " + vb.getName().toString());
                              logger.log( Level.FINE, " --> " + vb.getValue().toString());
                    }



    }

           /**
            * <P>This method is define to handle SNMPv1 traps
            * that are received by the session. The parameters
```

```
             * allow the handler to determine the host, port,
             * and community string of the received PDU.</P>
             *
             * @param session     The SNMP session
             * @param agent                 The Trap sender
             * @param port                  The port of the sender
             * @param community   The community string
             * @param pdu                   The SNMP trap pdu
             *
             */
            public void snmpReceivedTrap(SnmpTrapSession          session,
                                         InetAddress     agent,
                                         int             port,
                                         SnmpOctetString community,
                                         SnmpPduTrap     pdu) {

        logger.log( Level.INFO, "Received V1 Trap from " + agent + " on port " + port);
        logger.log( Level.FINE, "Ip Address.................. " + pdu.getAgentAddress() );
        logger.log( Level.FINE, "Enterprise Id.............. " + pdu.getEnterprise() );
        logger.log( Level.FINE, "Generic ................... " + pdu.getGeneric() );
        logger.log( Level.FINE, "Specific .................. " + pdu.getSpecific() );
        logger.log( Level.FINE, "TimeStamp ................. " + pdu.getTimeStamp() );
        logger.log( Level.FINE, "Length..................... " + pdu.getLength() );

        int k = pdu.getLength();

        for (int i = 0; i < k ; i++ ) {
            SnmpVarBind vb = pdu.getVarBindAt(i);
            System.out.print("Varbind[" + i + "] := " + vb.getName().toString());
            logger.log( Level.FINE," --> " + vb.getValue().toString());
        }


        // Do some stuff here to fire some events.



    }


            /**
             * <P>This method is invoked if an error occurs in
             * the trap session. The error code that represents
             * the failure will be passed in the second parameter,
             * 'error'. The error codes can be found in the class
             * SnmpTrapSession class.</P>
             *
             * <P>If a particular PDU is part of the error condition
             * it will be passed in the third parameter, 'pdu'. The
             * pdu will be of the type SnmpPduRequest or SnmpPduTrap
             * object. The handler should use the "instanceof" operator
             * to determine which type the object is. Also, the object
             * may be null if the error condition is not associated
             * with a particular PDU.</P>
             *
             * @param session     The SNMP Trap Session
             * @param error                 The error condition value.
             * @param ref                   The PDU reference, or potentially null.
             *                              It may also be an exception.
             *
             *
             */
            public void snmpTrapSessionError(SnmpTrapSession      session,
                                             int                              error,
                                             Object                ref) {

        logger.log(Level.WARNING, "SNMP Trap Session Error");

        // This error code is not actaully implemented at the moment
        if( error == SnmpTrapSession.ERROR_INVALID_PDU ) {
            logger.log(Level.WARNING, "\tError: "+error+" ERROR_INVALID_PDU: "+ref);
        } else if( error == SnmpTrapSession.ERROR_EXCEPTION) {
            logger.log(Level.WARNING, "\tError: "+error+" ERROR_EXCEPTION: "+ref);
            stop(); // close the session
                    } else {
            logger.log(Level.WARNING, "\tError: "+error+" ERROR_UNDEFINED: "+ref);
        }

    }
}
```

F.1.9. LinuxSnmpTrapDaemonImpl.java

```
/**
 * $Id: LinuxSnmpTrapDaemonImpl.java,v 1.2 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */
package apt.masterswitch.snmp;

import java.io.InputStream;
import java.io.InputStreamReader;
import java.io.BufferedReader;
import java.io.IOException;
import java.util.logging.Logger;
import java.util.logging.Level;


/**
 * Description:
 * <p>
 * This is an implementation of the SnmpTrapDaemon using the
 * linux command line tool /usr/sbin/snmptrapd
 * <p>
 * snmptrapd must be run with root permissions. This is
 * achieved by using the "sudo" linux tool.
 * <p>
 * The stderr of snmptrapd is captured and used to
 * fireSnmpTrapReceived() events when a new trap is received.
 * <p>
 * For more information see "man snmptrapd"
 * <p>
 *
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.2 $
 * @see apt.masterswitch.snmp.SnmpTrapListener
 */
public class LinuxSnmpTrapDaemonImpl extends AbstractSnmpTrapDaemon {


    private static String snmptrapdCommand = "sudo /usr/sbin/snmptrapd -P";

    private volatile boolean stopRequested;
    private volatile boolean running;
    private BufferedReader buffer;
    private Process proc;

    private StdErrReader readerThread;

    private final Logger log = Logger.getLogger( getClass().getName() );

    public static LinuxSnmpTrapDaemonImpl instance = new LinuxSnmpTrapDaemonImpl();

    private LinuxSnmpTrapDaemonImpl() {}


    /**
     * Start the <code>/usr/sbin/snmptrapd</code> daemon and begin listening
     * to its stderr so that we can find out trap information.
     * <p>
     * This will trigger the {@link apt.masterswitch.snmp.SnmpTrapListener#snmpTrapDaemonStarted() }
     * method to be called on registered {@link apt.masterswitch.snmp.SnmpTrapListener SnmpTrapListeners}
     */
    public void start() {

        if( !running ) {

            try {
                stopRequested = false;


                Runtime runtime = Runtime.getRuntime();

                proc = runtime.exec(snmptrapdCommand);
                InputStream stderr = proc.getErrorStream();

                InputStreamReader reader = new InputStreamReader(stderr);

                // Make the buffer size=1 so that readLine() returns as soon as a
                // line is written to the buffer
```

```
                buffer = new BufferedReader(reader,1);

                readerThread = new StdErrReader();
                readerThread.start();
                running = true;
                logger.log( Level.INFO, "Linux SnmpTrapDaemon Started");
                fireSnmpTrapDaemonStarted();
            } catch (IOException e) {
                logger.log( Level.INFO, "Could not start Linuz SnmpTrapDaemon, IO err",e);
            }

        } else {

            logger.log( Level.INFO, "Linux SnmpTrapDaemon Stopped");
        }
    }

    /**
     *  Stop listening to SNMP traps
     * <p>
     * Kill the <code>/usr/sbin/snmptrapd</code> process
     * <p>
     * This will trigger the {@link apt.masterswitch.snmp.SnmpTrapListener#snmpTrapDaemonStopped() }
     * method to be called on registered {@link apt.masterswitch.snmp.SnmpTrapListener SnmpTrapListeners}
     */
    public void stop() {

        if( running ) {
            running = false;

            readerThread.requestStop();
            proc.destroy();

            proc = null;
            buffer = null;
            logger.log( Level.INFO, "Linux SnmpTrapDaemon Stopped");
            fireSnmpTrapDaemonStopped();
        } else {
            log.log(Level.WARNING, "Cannot Stop snmptrapd, it is not running");
        }

    }

    private class StdErrReader extends Thread {

        private volatile boolean stopRequested;

        public StdErrReader() {
            stopRequested = false;
        }

        public void requestStop() {
            stopRequested = true;
        }

        public void run() {

            running = true;

            while( !stopRequested ) {

                String trapMsg = "";
                try {
                    /**
                     * Execution of this thread will block
                     * here until a new line is read
                     */
                    trapMsg = buffer.readLine();
                } catch (IOException e) {
                    log.log(Level.WARNING, "I/O Error while reading stdout of snmptrapd",e );
                }

                log.log(Level.INFO, trapMsg );
                fireSnmpTrapReceived();
            }

            try {
                buffer.close();
            } catch (IOException e) {
                // The proc was probably killed
            }

        }
```

```
    }
}

/**
 *      output of "man snmptrapd"
 * ************************************************************


SNMPTRAPD(8)                                          SNMPTRAPD(8)
NAME
       snmptrapd - Receive and log snmp trap messages.
SYNOPSIS
       snmptrapd  [common  options]  [-P] [-o file] [-s] [-f] [-p
       port] [-e] [-l [d0-7]] [-a] [-C] [-c confFile] [-F FORMAT]
DESCRIPTION
       Snmptrapd  is  an  SNMP application that receives and logs
       snmp trap messages sent to the SNMP-TRAP port (162) on the
       local machine.
       The log messages are of the form:
       Sep 17 22:39:52 suffern snmptrapd: 128.2.13.41: Cold Start
       Trap (0) Uptime: 8 days, 0:35:46
       Snmptrapd must be run as root so that UDP port 162 can  be
       opened.
COMMAND LINE ARGUMENTS
       In  addition to the command arguments described under snm
       pcmd(1) the following arguments are understood:
       -P     Print the logged messages to stderr.
       -o file
              Logs messages to a given file.
       -p port
              Specifies the port to run on, if the default 162 is
              not desired.
       -s     Log  the  messages to syslog(8).  These syslog mes
              sages are sent with the level of  LOG_WARNING,  and
              to the LOG_LOCAL0 facility (by default).  The demon
              will also fork away from its caller when the syslog
              facilities  are  used.   This is the default unless
              the '-P' flag or '-o' flag is used.
       -n     Don't do reverse translation  from  IP  address  to
              host name.
       -l [d0-7]
              Specifies  the  syslog  facility  to  use, demon or
              local[0-7].
       -a     makes snmptrapd ignore AuthenticationFailure traps
       -d     Causes the application to  dump  input  and  output
              packets.
       -D     Turn debugging output on.
       -f     Don't  fork  away  from  the caller when using sys
              log().
       -C     Don't read the default set of configuration  files.
       -c confFile
              Force  the  reading  of confFile as a configuration
              file.
       -F FORMAT
              When logging to standard output, use the format  in
              the string FORMAT.
       FORMAT  is a printf-like string.  Snmptrapd interprets the
       following formatting sequences:
       %%     a literal %
       %t     decimal number of seconds since the operating  sys
              tem's epoch
       %y     current year
       %m     current (numeric) month
       %l     current day of month
       %h     current hour
       %j     current minute
       %k     current second
       %T     up-time in seconds (in decimal)
       %Y     the year field from the up-time
       %M     the numeric month field from the up-time
       %L     the day of month field from the up-time
       %H     the hour field from the up-time
       %J     the minute field from the up-time
       %K     the seconds field from the up-time
       %A     agent's hostname if available, otherwise IP address
       %a     agent's IP address
       %B     PDU's hostname if available, otherwise IP address
       %b     PDU's IP address
       %N     Enterprise string
       %w     Trap type (numeric, in decimal)
```

```
       %W     Trap description
       %q     Trap sub-type (numeric, in decimal)
       %P     Security information from the PDU  (community  name
              for v1/v2c, user and context for v3)
       %v     list of trap's variables
       In  addition  to  these  values,  you  may also specify an
       optional field width and precision, just as in printf, and
       a flag value. The following flags are legal:
       -      left justify
       0      use leading zeros
       #      use alternate form
       The "use alternate form" flag changes the behavior of some
       format flags.  Normally,  the  fields  that  display  time
       information base it on the local time, but this flag tells
       them to use GMT instead.  Also, the variable list is  nor
       mally  a tab-separated list, but this flag changes it to a
       comma-separated one. The alternate form for the uptime  is
       similar to "3 days, 0:14:34.65"
       Examples:
       To  get a message like "14:03 TRAP3.1 from humpty.ucd.edu"
       you could use something like this:
              snmptrapd -P -F "%02.2h:%02.2j TRAP%w.%q from %A\n"
       If  you  want  the same thing but in GMT rather than local
       time, use
              snmptrapd -P  -F  "%#02.2h:%#02.2j  TRAP%w.%q  from
              %A\n"
EXTENSIBILITY AND CONFIGURATION
       See the snmptrapd.conf(5) manual page.
SEE ALSO
       snmpcmd(1), syslog(8), variables(5)
                          07 Aug 2001                SNMPTRAPD(8)
(END)
 */
```

F.1.10. SnmpTrapListener.java

```
/**
 * $Id: SnmpTrapListener.java,v 1.3 2002/10/22 08:23:11 oliverm Exp $
 * Author: Oliver Mather
 *
 */

package apt.masterswitch.snmp;


/**
 * Description:
 * <p>
 * The listener interface for receiving SnmpTrapDaemon Events.
 * <p>
 * @author  $Author: oliverm $ <a href="mailto:oliverm@student.unsw.edu.au">Oliver Mather</a>
 * @version $Revision: 1.3 $
 * @see apt.masterswitch.snmp.SnmpTrapDaemon
 *
*/
public interface SnmpTrapListener {

    /**
     * This method is invoked by the SnmpTrapDaemon when
     * it is now listening for SNMP traps
     */
    public void snmpTrapDaemonStarted();

    /**
     * This method is invoked by the SnmpTrapDaemon when
     * it no longer listening for SNMP traps
     */
    public void snmpTrapDaemonStopped();



    /**
     * This method is called whenever a SNMP trap is
     * received by the SnmpTrapDaemon to which this listener
     * is registered.
     */
    public void snmpTrapReceived();


/*  These methods should be implemented to provide decoding
    of the traps to identify their specific meaning:

    public void snmpV1TrapReceived(SnmpV1Trap trap);
    public void snmpV2TrapReceived(SnmpV2Trap trap);
    public void snmpTrapError();
*/
}
```

F.2. APT deployment system

F.2.1. apt-client-base.jnlp

```
<?xml version="1.0" encoding="utf-8"?>
<!-- JNLP base file for the apt client gui
     $Id$
     At build time, the string #version-key#, is replaced
     by the specific build key -->
<jnlp
  spec="1.0+"
  codebase="http://mcba5.phys.unsw.edu.au/~apt/software/webstart/"
  href="./apt-client.jnlp">

  <information>
    <title>APT Client ver:#version-key#</title>
    <icon href="./images/webstart-icon.gif"/>
    <vendor>UNSW School of Physics</vendor>
    <homepage href="http://mcba5.phys.unsw.edu.au/~apt"/>
    <description>APT Remote Client User Interface version:"#version-key#" </description>
    <description kind="short">Enhanced Client User Interface for controlling the Automated Patrol
Telescope</description>

    <!-- <offline-allowed/>
           This tag is omitted, because we want users to be forced to run
           the latest version by reloading
           http://mcba5.phys.unsw.edu.au/~apt/software/webstart/apt-client.jnlp   -->
  </information>

  <!-- We must specify all-permissions because we need network access.
       Currently webstart does not support finer grained access control -->
  <security>
      <all-permissions/>
  </security>

  <resources>

    <j2se version="1.4"/>

    <jar href="./apt__V#version-key#/apt__V#version-key#.jar"/>
    <jar href="./apt__V#version-key#/config__V#version-key#.jar"/>

    <!-- All these libraries must be signed by the user aptDev ( this
         is automated by the lib build.xml file  -->
    <jar href="./lib/skinlf.jar"/>
    <jar href="./lib/lf-skins.jar"/>
    <jar href="./lib/rachel.jar"/>
    <jar href="./lib/ol__V1.jar"/>
    <jar href="./lib/jas__V2.2.jar"/>
    <jar href="./lib/cryptix-jce-api.jar"/>
    <jar href="./lib/cryptix-jce-compat.jar"/>
    <jar href="./lib/cryptix-jce-provider.jar"/>
    <jar href="./lib/cryptix-sasl.jar"/>
    <jar href="./lib/drama.jar"/>
    <jar href="./lib/javax-sasl.jar"/>
    <jar href="./lib/jcan.jar"/>
    <jar href="./lib/jsdt-client-socket.jar"/>
    <jar href="./lib/jsdt.jar"/>
    <jar href="./lib/log4j.jar"/>

    <property name="log4j.configuration"
           value="jar:file:./apt__V#version-key#/config__V#version-key#.jar!log.properties" />
    <property name="java.util.logging.config.URL"
           value="jar:file:./apt__V#version-key#/config__V#version-key#.jar!/javalog.properties" />
    <property name="java.util.logging.config.class"
           value="apt.util.LogConfigUrlLoader" />

  </resources>

  <application-desc main-class="apt.client.Main"/>
</jnlp>
```

F.2.2. apt-client-keith.jnlp

```
<?xml version="1.0" encoding="utf-8"?>
<!-- JNLP base file for the apt client gui
     $Id: apt-client-keith-base.jnlp,v 1.4 2002/10/24 01:32:11 oliverm Exp $
     At build time, the string #version-key#, is replaced
     by the specific build key -->
<jnlp
  spec="1.0+"
  codebase="http://mcba5.phys.unsw.edu.au/~apt/software/webstart/"
  href="./apt-client-keith.jnlp">
  <information>
    <title>Keiths APT Client ver:#version-key#</title>
    <!-- <icon href="./images/webstart-icon.gif"/> -->
    <vendor>UNSW School of Physics</vendor>
    <homepage href="http://mcba5.phys.unsw.edu.au/~apt"/>
    <description>APT Remote Client User Interface version:"#version-key#" </description>
    <description kind="short">Enhanced Client User Interface for controlling the Automated Patrol
Telescope</description>

    <!-- <offline-allowed/>
           This tag is omitted, because we want users to be forced to run
           the latest version by reloading
           http://mcba5.phys.unsw.edu.au/~apt/software/webstart/apt-client-keith.jnlp   -->

  </information>


  <!-- We must specify all-permissions because we need network access.
       Currently webstart does not support finer grained access control -->
  <security>
      <all-permissions/>
  </security>

  <resources>

    <j2se version="1.4"/>

    <jar href="./apt__V#version-key#/apt__V#version-key#.jar"/>
    <jar href="./apt__V#version-key#/config__V#version-key#.jar"/>


    <!-- All these libraries must be signed by the user aptDev ( this
         is automated by the lib build.xml file   -->
    <jar href="./lib/jas__V2.2.jar"/>
    <jar href="./lib/cryptix-jce-api.jar"/>
    <jar href="./lib/cryptix-jce-compat.jar"/>
    <jar href="./lib/cryptix-jce-provider.jar"/>
    <jar href="./lib/cryptix-sasl.jar"/>
    <jar href="./lib/drama.jar"/>
    <jar href="./lib/javax-sasl.jar"/>
    <jar href="./lib/jcan.jar"/>
    <jar href="./lib/jsdt-client-socket.jar"/>
    <jar href="./lib/jsdt.jar"/>
    <jar href="./lib/log4j.jar"/>

    <property name="log4j.configuration"
           value="jar:file:./apt__V#version-key#/config__V#version-key#.jar!log.properties" />
    <property name="java.util.logging.config.URL"
           value="jar:file:./apt__V#version-key#/config__V#version-key#.jar!/javalog.properties" />
    <property name="java.util.logging.config.class"
           value="apt.util.LogConfigUrlLoader" />

  </resources>

  <application-desc main-class="apt.client.gui.ptcs.ui.PtcsUi"/>
</jnlp>
```

F.2.3. apt build.xml

```
<?xml version="1.0"?>
<!--
$Id: build.xml,v 1.24 2002/10/24 01:35:35 oliverm Exp $

Buildfile for apt java classes.

Use "ant" to use this buildfile. Download ant from jakarta.apache.org
By Keith Bannister

Drastic changes made to this file by Oliver Mather,
   - simplify it
   - incorporate versioning and automated deployment to webstart

-->

<project name="apt" default="usage" basedir=".">

   <!--  global properties  -->
   <property name="version-key" value="test-0.96"/>

   <!-- source directories -->
   <property name="src-dir"     value="source"/>
   <property name="lib-dir"     value="../lib"/>
   <property name="doc-dir"     value="doc"/>
   <property name="config-dir"  value="config"/>
   <property name="bin-dir"     value="bin"/>


   <!-- directories created locally during build
        Note: the "dist-dir-name" prefix of "apt__V" matches
              the prefix hardcoded in apt-client-base.jnlp

   -->
   <property name="build-dir"           value="build"/>
   <property name="build-classes-dir"   value="${build-dir}/classes"/>
   <property name="build-doc-dir"       value="${build-dir}/doc"/>
   <property name="dist-base-dir"       value="dist"/>
   <property name="dist-dir-name"       value="apt__V${version-key}" />
   <property name="dist-dir"            value="${dist-base-dir}/${dist-dir-name}" />



   <!-- filenames created by build process -->
   <property name="apt.client.jnlpfile"       value="${dist-dir}/apt-client__V${version-key}.jnlp"/>
   <property name="apt.client-keith.jnlpfile" value="${dist-dir}/apt-client-keith__V${version-key}.jnlp"/>
   <property name="apt.jarfile"         value="${dist-dir}/apt__V${version-key}.jar"/>
   <property name="apt.config.jarfile"  value="${dist-dir}/config__V${version-key}.jar"/>
   <property name="apt.src.tar"         value="${dist-dir}/apt-source__V${version-key}.tar"/>
   <property name="apt.src.tar.gz"      value="${dist-dir}/apt-source__V${version-key}.tar.gz"/>
   <property name="apt.doc.tar"         value="${dist-dir}/apt-docs__V${version-key}.tar"/>
   <property name="apt.doc.tar.gz"      value="${dist-dir}/apt-docs__V${version-key}.tar.gz"/>


   <!-- jarsigning parameters.  jarsigning is required by webstart -->
   <property name="keystore"     value=".keystore"/>
   <property name="keypass"      value="aptdev"   />
   <property name="keystorepass" value="aptdev"   />
   <property name="keyalias"     value="aptdev"   />

   <!-- NOTE these two properties are duplicated in lib/build.xml  -->
   <!-- directories used on mcba5 -->
   <property name="mcba5-dist-base-dir" value="~apt/public_html/software/webstart" />

   <!-- directories used on mistral -->
   <property name="mistral-dist-base-dir" value="~apt/APTAutomation-MultiVer" />
   <!-- NOTE these two properties are duplicated in lib/build.xml  -->

   <property name="scp.command"             value="scp"/>
   <property name="scp.mcba5.destination"   value="apt@mcba5.phys.unsw.edu.au:${mcba5-dist-base-dir}"/>
   <property name="scp.mcba5.source"        value="apt@mcba5.phys.unsw.edu.au:${mcba5-dist-base-dir}/${dist-
dir-name}"/>
   <property name="scp.mistral.destination" value="apt@mistral.anu.edu.au:${mistral-dist-base-dir}/" />



    <!-- Classpath
```

```
        Note: if you install an additional library here,
              please add it to the check below at the
              init target
   -->
  <path id="classpath">
    <fileset id="all-lib-jars" dir="${lib-dir}">

        <!-- we cannot just include all jars because multiple versions
             of the same lib will be installed in ${lib-dir}.
             <include name="**/*.jar"/>

             Note that each lib relese must have a different name.

             libXXX.jar files must never be overwritten.

        -->

        <include name="cryptix-jce-api.jar"/>
        <include name="cryptix-jce-compat.jar"/>
        <include name="cryptix-jce-provider.jar"/>
        <include name="cryptix-sasl.jar"/>
        <include name="javax-sasl.jar"/>
        <include name="log4j.jar"/>
        <include name="jas__V2.2.jar"/>
        <include name="jcan.jar"/>
        <include name="jsdt.jar"/>
        <include name="jsdt-client-socket.jar"/>
        <include name="junit.jar"/>
        <include name="drama.jar"/>
        <include name="jsnmp.jar"/>
        <include name="agentapi.jar"/>
        <include name="ol.jar"/>
        <include name="skinlf.jar" />
        <include name="lf-skins.jar" />
        <include name="rachel.jar" />

    </fileset>
  </path>



 <target name="usage" >
     <echo>
    APT Build File
    -----------------------------------------------------

    Primary targets are:
      init       --> prepares build dir structure
      clean      --> removes all files and dirs created
                     by ant
      compile-sp --> Compiles SP interface
      compile    --> Compile apt package
      apt-jar    --> create apt.jar
      config-jar --> create config.jar
      sign-jars  --> sign these jars (required for webstart deployment)
      prepare    --> prepare the ${dist-dir}.
                .i.e dynamically create the jnlp,deploy
               and runServer scripts.



      upload         --> upload the ${dist-dir} to mcba5
      upload-mistral --> copy ${dist-dir} from mcba5 to mistral



    Optional targets:
      source-tar.gz  --> creates ${apt.src.tar.gz}
      api-doc        --> runs javadoc
      doc-tar.gz     --> creates ${apt.doc.tar.gz} which contains
                         ${doc-dir} and the javadocs

                         These files are created in the ${dist-dir}
                         and will consequently be uploaded by using
                         the 'upload' target


      test-all       --> Run JUnit test... usage of these targets
      test-ui        --> has not been documented

      Notes
      -----
```

```
      SCP Setup

      Note that to use scp, authenticed remote ssh
      must be setup on mcba5 AND mistral. This is done by
      the following two commands:

      Your machine:
      scp ~/.ssh/id_dsa.pub apt@mcba5.phys.unsw.edu.au:~/.ssh/temp-pub-key

      User apt on mcba5:
      cat ~/.ssh/temp-pub-key >> ~/.ssh/authorized_keys2
      rm  ~/.ssh/temp-pub-key


 </echo>
</target>



<target name="init">
   <tstamp/>

   <mkdir dir="${build-dir}"/>
   <mkdir dir="${build-classes-dir}"/>
   <mkdir dir="${build-doc-dir}"/>
   <mkdir dir="${dist-base-dir}"/>
   <mkdir dir="${dist-dir}"/>


   <condition property="haveAllJars" >
     <and>
       <available file="${lib-dir}/cryptix-jce-api.jar"/>
       <available file="${lib-dir}/cryptix-jce-compat.jar"/>
       <available file="${lib-dir}/cryptix-jce-provider.jar"/>
       <available file="${lib-dir}/cryptix-sasl.jar"/>
       <available file="${lib-dir}/javax-sasl.jar"/>
       <available file="${lib-dir}/log4j.jar"/>
       <available file="${lib-dir}/jas.jar"/>
       <available file="${lib-dir}/jcan.jar"/>
       <available file="${lib-dir}/jsdt.jar"/>
       <available file="${lib-dir}/jsdt-client-socket.jar"/>
       <available file="${lib-dir}/junit.jar"/>
       <available file="${lib-dir}/drama.jar"/>
       <available file="${lib-dir}/jsnmp.jar"/>
       <available file="${lib-dir}/agentapi.jar"/>
       <available file="${lib-dir}/ol.jar"/>
       <available file="${lib-dir}/skinlf.jar" />
       <available file="${lib-dir}/lf-skins.jar" />
       <available file="${lib-dir}/rachel.jar" />
     </and>
   </condition>


   <fail unless="haveAllJars" message="A required jar file is missing"/>
</target>



<!--  ********** COMPILE ********** -->
<target name="compile-sp"
           depends="init"
           description="Compile SP because it won't by itself">
   <javac destdir="${build-classes-dir}"
          source="1.4"
          classpathref="classpath" >
   <src path="${src-dir}"/>
    <include name="apt/sp/APTSPClient.java"/>
   </javac>
</target>

<target name="compile"
           depends="init,compile-sp"
           description="Compile the APT classes">

  <javac destdir="${build-classes-dir}"
           source="1.4"
           debug="yes"
           deprecation="true"
```

```
            classpathref="classpath"
            srcdir="${src-dir}" >

         <exclude name="apt/sp/**"/>
  </javac>

  <!-- copy the docs  -->
  <copy todir="${build-doc-dir}">
        <fileset dir="${doc-dir}" />
  </copy>


  <!-- copy images used by the client gui -->
  <copy todir="${build-classes-dir}">
        <fileset dir="${src-dir}">
          <include name="**/*.gif"/>
        </fileset>
  </copy>

</target>
<!--  ********** END COMPILE ********** -->



<!--  ********** DIST ********** -->
<target name="apt-jar"
        depends="compile"
        description="Create the apt jar file">

   <jar jarfile="${apt.jarfile}"
           basedir="${build-classes-dir}"/>


</target>



<target name="config-jar"
        depends="init"
           description="Create jar file that contains config files">

    <jar jarfile="${apt.config.jarfile}"
         basedir="${config-dir}" />


</target>


<target name="sign-jars" depends="config-jar,apt-jar" >
  <echo>

  Signing the jarfiles as ${keyalias} using keystore ${keystore}

  This must be the same keystore and alias used to
  sign all the jar files from the 'lib' module.
  Webstart does not allow jars to be signed by different
  users.


  </echo>
    <signjar jar="${apt.config.jarfile}"
                  alias="${keyalias}"
                  keypass="${keypass}"
                  storepass="${keystorepass}"
                  keystore="${keystore}" />

   <signjar jar="${apt.jarfile}"
                  alias="${keyalias}"
                  keypass="${keypass}"
                  storepass="${keystorepass}"
                  keystore="${keystore}" />


</target>



<target name="source-tar.gz"
           depends="init"
           description="tar.gz up the source">
   <tar  tarfile="${apt.src.tar}" basedir="${src-dir}"/>
   <gzip zipfile="${apt.src.tar.gz}" src="${apt.src.tar}"/>
```

```
   <delete  file="${apt.src.tar}"/>
</target>
<!--  ********** END DIST ********** -->



<!--  ********** DOCUMENTATION **********
      optional, these targets pepare the docs and stick them in the
      deploy dir.
-->
<target name="api-doc"
          description="Make the standard java api">
  <javadoc sourcepath="${src-dir}"
             destdir="${build-doc-dir}/api"
             packagenames="apt.*"
             classpathref="classpath"
             defaultexcludes="yes"
             package="true"
             version="true"
             author="true"
             WindowTitle="APT API Documentation"
             additionalparam="-source 1.4">
     <doctitle>APT API Documentation</doctitle>
   </javadoc>
</target>


<target name="doc-tar.gz"
          depends="init, api-doc"
          description="Generate documentation tar.gz">
   <tar  tarfile="${apt.doc.tar}" basedir="${build-doc-dir}"/>
   <gzip zipfile="${apt.doc.tar.gz}" src="${apt.doc.tar}"/>
   <delete  file="${apt.doc.tar}"/>
</target>
<!--  ********** END DOCUMENTATION ********** -->









<!-- ********** DEPLOY ********** -->

<target name="prepare"  depends="sign-jars" >


     <!-- copy the config dir -->
     <copy todir="${dist-dir}/config">
          <fileset dir="${config-dir}" />
     </copy>

        <!-- when the server is run, it expects this dir to be created -->
        <mkdir dir="${dist-dir}/log"/>

        <!-- create the apt-client jnlp file -->
        <copy file="${bin-dir}/apt-client-base.jnlp"
             tofile="${apt.client.jnlpfile}" />
        <replace file="${apt.client.jnlpfile}"
                 token="#version-key#"
                 value="${version-key}" />

        <!-- create Keiths apt-client jnlp file -->
        <copy file="${bin-dir}/apt-client-keith-base.jnlp"
             tofile="${apt.client-keith.jnlpfile}" />
        <replace file="${apt.client-keith.jnlpfile}"
                 token="#version-key#"
                 value="${version-key}" />

        <!-- create the runKeithsGui.bat file -->
        <copy file="${bin-dir}/runKeithsGui-base.bat"
             tofile="${dist-dir}/runKeithsGui.bat" />
        <replace file="${dist-dir}/runKeithsGui.bat"
                 token="#version-key#"
                 value="${version-key}" />



        <!-- create the runOliversGui.bat file -->
```

```
          <copy file="${bin-dir}/runOliversGui-base.bat"
               tofile="${dist-dir}/runOliversGui.bat" />
          <replace file="${dist-dir}/runOliversGui.bat"
                   token="#version-key#"
                   value="${version-key}" />



          <!-- create the runOliversGui file -->
          <copy file="${bin-dir}/runOliversGui-base"
               tofile="${dist-dir}/runOliversGui" />
          <replace file="${dist-dir}/runOliversGui"
                   token="#version-key#"
                   value="${version-key}" />


          <!-- create the runServer file -->
          <copy file="${bin-dir}/runServer-base"
               tofile="${dist-dir}/runServer" />
          <replace file="${dist-dir}/runServer"
                   token="#version-key#"
                   value="${version-key}" />

          <!-- create the upadteWebstart file -->
          <copy file="${bin-dir}/updateWebstart-base"
               tofile="${dist-dir}/updateWebstart" />
          <replace file="${dist-dir}/updateWebstart"
                   token="#version-key#"
                   value="${version-key}" />


          <!-- create the runSPServer file -->
          <copy file="${bin-dir}/runSPServer-base"
               tofile="${dist-dir}/runSPServer" />
          <replace file="${dist-dir}/runSPServer"
                   token="#version-key#"
                   value="${version-key}" />


          <!-- create the runUserman file -->
          <copy file="${bin-dir}/runUserman-base"
               tofile="${dist-dir}/runUserman" />
          <replace file="${dist-dir}/runUserman"
                   token="#version-key#"
                   value="${version-key}" />

          <!-- create the setClasspath file -->
          <copy file="${bin-dir}/setClasspath-base"
               tofile="${dist-dir}/setClasspath" />
          <replace file="${dist-dir}/setClasspath"
                   token="#version-key#"
                   value="${version-key}" />


          <!-- create the versionPropeties file -->
          <copy file="${config-dir}/version.properties-base"
               tofile="${dist-dir}/config/version.properties" />
          <replace file="${dist-dir}/config/version.properties"
                   token="#version-key#"
                   value="${version-key}" />


 </target>


 <target name="upload" depends="prepare" >
    <property name="scp-upload-mcba5-args" value=" -C -r ${dist-dir} ${scp.mcba5.destination}" />
    <echo>
    Uploading to mcba5...
    % ${scp.command} ${scp-upload-mcba5-args}
    </echo>
       <exec executable="${scp.command}">

          <arg line="${scp-upload-mcba5-args}" />
       </exec>


 </target>


<target name="upload-mistral" depends="upload" >
```

```
    <property name="scp-upload-mistral-args" value=" -C -r  ${scp.mcba5.source}  ${scp.mistral.destination}"
/>

    <echo>
    Copying ${dist-dir-name} from mcba5 to mistral
    % ${scp.command} ${scp-upload-mistral-args}
    </echo>

    <exec executable="${scp.command}">
        <arg line="${scp-upload-mistral-args}"  />
    </exec>

 </target>



  <target name="clean"
            description="Clean up dist and build directories">
     <delete dir="${dist-base-dir}"/>
     <delete dir="${build-dir}"    />
  </target>



  <!-- ********** TEST ********** -->
  <target name="test-all"
            depends="compile"
            description="Run JUnit on all available tests">
      <junit printsummary="on">
        <classpath>
           <path refid="classpath"/>
           <pathelement location="${build-classes-dir}"/>
        </classpath>
        <test name="apt.AllTests"/>
        <formatter type="plain"/>
      </junit>
  </target>

  <target name="test-ui"
            depends="compile"
            description="Run JUnit Gui">
      <java classname="junit.swingui.TestRunner"
              fork="yes">
         <arg value="apt.AllTests"/>
         <jvmarg value="-ea"/>
         <classpath>
            <path refid="classpath"/>
            <pathelement location="./lib/junit.jar"/>
            <pathelement location="${build-classes-dir}"/>
         </classpath>
      </java>
  </target>
  <!-- ********** END TEST ********** -->

</project>
```

F.2.4. lib build.xml

```
<?xml version="1.0"?>
<!--
$Id: build.xml,v 1.4 2002/10/03 08:32:20 oliverm Exp $

Ant build file for the apt library files

This is a utility ant buildfile used to:
          * sign all the jars (required by webstart)
          * deploy the libs (jars & .so) to mcba5 and mistral



-->

<project name="lib" default="usage" basedir=".">

   <!-- directories used by build -->
   <property name="lib-dir"  value="." />

   <!-- directories created during build -->
   <property name="dist-dir-name" value="signed-jars" />
   <property name="dist-dir"      value="${dist-dir-name}" />
   <!-- filenames created -->

   <!-- jarsigning parameters.  jarsigning is required by webstart
        Note that the apt module must be checked out to give us
        access to the keystore
   -->
   <property name="keystore"     value="../apt/.keystore"/>
   <property name="keypass"      value="aptdev"   />
   <property name="keystorepass" value="aptdev"   />
   <property name="keyalias"     value="aptdev"   />


   <!-- NOTE these two properties are duplicated in apt/build.xml  -->
   <!-- directories used on mcba5 -->
   <property name="mcba5-dist-base-dir" value="~apt/public_html/software/webstart" />

   <!-- directories used on mistral -->
   <property name="mistral-dist-base-dir" value="~apt/APTAutomation-MultiVer" />
   <!-- NOTE these two properties are duplicated in apt/build.xml  -->


   <property name="scp.command"           value="scp"/>
   <property name="scp.mcba5.destination" value="apt@mcba5.phys.unsw.edu.au:${mcba5-dist-base-dir}" />
   <property name="scp.mcba5.source"        value="apt@mcba5.phys.unsw.edu.au:${mcba5-dist-base-dir}/${dist-
dir-name}"/>
   <property name="scp.mistral.destination" value="apt@mistral.anu.edu.au:${mistral-dist-base-dir}/" />



   <fileset id="all-lib-jars" dir="${lib-dir}">
       <include name="*.jar"/>
   </fileset>


   <fileset id="linux-so-libs" dir="${lib-dir}">
       <include name="*.so"/>
   </fileset>

   <target name="usage" >
    <echo>
      APT Library files
      ------------------------------------------------------

      Available targets are:
        init           --> creates ${dist-dir} and copies .so files to it
        clean          --> removes the directory ${dist-dir}
        sign-jars      --> copies the jars to ${dist-dir}
                           and then signs them as ${keyalias}
        upload         --> Copies everything in ${dist-dir} to mcba5
        upload-mistral --> Copies ${dist-dir} from mcba5 to mistral



        Notes
        -----
```

```
      SCP Setup

      Note that to use scp, authenticed remote ssh
      must be setup on mcba5 AND mistral. This is done by
      the following two commands:

      Your machine:
      scp ~/.ssh/id_dsa.pub apt@mcba5.phys.unsw.edu.au:~/.ssh/temp-pub-key

      User apt on mcba5:
      cat ~/.ssh/temp-pub-key >> ~/.ssh/authorized_keys2
      rm  ~/.ssh/temp-pub-key


      Versioning

      To preseve the multi-versioning of these build files,
      ANY new lib that is added must not overwrite an existing
      lib. All other build + config files must be updated
      manually to 'swap' over to the newer lib file of a
      diff name.

      The ant build.xml file in the 'lib' module can be used
      to sign and deploy all the jars.

   </echo>
  </target>


  <target name="init">
     <tstamp/>
     <mkdir dir="${dist-dir}"/>

     <copy todir="${dist-dir}">
          <fileset refid="linux-so-libs" />
     </copy>

  </target>


  <target name="sign-jars" depends="init">

    <!-- copy the jars -->
    <copy todir="${dist-dir}">
          <fileset refid="all-lib-jars" />
    </copy>

    <echo>

    Signing the jarfiles as ${keyalias} using keystore ${keystore}

    This must be the same keystore and alias used to
    sign apt.jar and config.jar from the 'apt' module.
    Webstart does not allow jars to be signed by different
    users.


    </echo>

    <signjar  alias="${keyalias}"
                    keypass="${keypass}"
                    storepass="${keystorepass}"
                    keystore="${keystore}" >

       <fileset id="copied-lib-jars" dir="${dist-dir}">
           <include name="**/*.jar"/>
       </fileset>
     </signjar>

  </target>


 <target name="upload">

  <property name="scp-mcba5-args" value=" -C -r ${dist-dir}  ${scp.mcba5.destination}"  />
  <echo>
    Uploading  ${dist-dir} to mcba5, please wait...
    % ${scp.command} ${scp-mcba5-args}
  </echo>

  <exec executable="${scp.command}">
```

```
        <arg line="${scp-mcba5-args}" />
    </exec>

  </target>


 <target name="upload-mistral" depends="upload" >

     <property name="scp-mistral-args" value=" -C -r  ${scp.mcba5.source}  ${scp.mistral.destination}" />

     <echo>
     Copying ${dist-dir-name} from mcba5 to mistral
     % ${scp.command} ${scp-mistral-args}
     </echo>

     <exec executable="${scp.command}">
         <arg line="${scp-mistral-args}"  />
     </exec>

 </target>


   <target name="clean"
             description="Clean up dist and build directories">
      <delete dir="${dist-dir}"/>
   </target>

</project>
```

F.3. CSIRO / SEARFE

F.3.1. Sample data file

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml:stylesheet type="text/xsl" href="Style.xsl" version="1.0" encoding="UTF-8" ?>

<SpectrumScan>

<ScanParameters>

    <Location
        Name="USyd Physics (A29) Roof"
        Longitude="151.18565"
        Latitude="-33.88961"
    />

    <Operator Name="Hansel" />

    <SignalPath>
        <Antenna Name="Discone 50-1300 MHz Antenna" />
        <AntennaToLNATransmissionLine Name="10m RJ50 Cable" />
        <LNA Name="None" />
        <LNAAttenuator Value="None" />
        <LNAToReceiverTransmissionLine Name="None" />
    </SignalPath>

    <Receiver
        Name="AOR AR-3000A"
        Mode="WFM"
        InternalRFAttenuator="Off"
        InternalShortwavePreamp="On"
    />

    <Scan
            StartTime="2002-08-28 19:38:07.254 EST"
            NumberOfScans="10" >

        <StartFrequency      Value="0090.0000" Unit="MHz" />
        <StopFrequency       Value="0110.0000" Unit="MHz" />
        <FrequencyIncrement  Value="0.1" Unit="MHz" />
        <DwellPerIncrement   Value="100" Unit="ms/increment" />
        <DwellPerScan        Value="0.0" Unit="hours/scan" />
    </Scan>

    <Notes>
        ~30 m extension lead attached to ~10 m Antenna Transmission Line Cable, so total Antenna Transmission
Line cable ~40 m.
    </Notes>

</ScanParameters>

<SpectrumScanData>

<SpectrumData Time="2002-08-28 19:38:13.974 EST" ScanNumber="1" Frequency="0090.0000" SignalStrength="5"
Errors="S=0,C=3" />
<SpectrumData Time="2002-08-28 19:38:14.184 EST" ScanNumber="1" Frequency="0090.1000" SignalStrength="8"
Errors="S=0,C=0" />
...
<SpectrumData Time="2002-08-28 19:39:29.72 EST" ScanNumber="2" Frequency="0105.8000" SignalStrength="10"
Errors="S=0,C=0" />
<SpectrumData Time="2002-08-28 19:39:29.282 EST" ScanNumber="2" Frequency="0105.9000" SignalStrength="9"
Errors="S=0,C=0" />

...
<SpectrumData Time="2002-08-28 19:45:10.623 EST" ScanNumber="10" Frequency="0109.9000" SignalStrength="8"
Errors="S=0,C=0" />
<SpectrumData Time="2002-08-28 19:45:10.833 EST" ScanNumber="10" Frequency="0110.0000" SignalStrength="6"
Errors="S=0,C=0" />
</SpectrumScanData>

</SpectrumScan>
```

F.4. TextSkin

F.4.1. TextSkin zipfile listing

```
[oliverm@mcba5:~] unzip -l BacklitLCD.zip
Archive:  BacklitLCD.zip
  Length     Date   Time    Name
 --------    ----   ----    ----
     1086  07-08-02 12:08   MBacklitLCD.gif
     1063  05-01-02 20:17   1BacklitLCD.gif
     1086  05-01-02 20:17   2BacklitLCD.gif
     1091  05-01-02 20:17   3BacklitLCD.gif
     1068  05-01-02 20:18   4BacklitLCD.gif
     1083  05-01-02 20:18   5BacklitLCD.gif
     1093  05-01-02 20:18   6BacklitLCD.gif
     1068  05-01-02 20:19   7BacklitLCD.gif
     1106  05-01-02 20:19   8BacklitLCD.gif
     1097  05-01-02 20:19   9BacklitLCD.gif
     1041  08-23-02 15:08   bSlashBacklitLCD.gif
     1031  08-23-02 15:03   colonBacklitLCD.gif
      580  05-01-02 20:21   defaultBacklitLCD.gif
     1037  08-23-02 15:08   fSlashBacklitLCD.gif
     1068  07-08-02 12:09   HBacklitLCD.gif
     1104  05-01-02 20:17   0BacklitLCD.gif
      607  08-23-02 15:06   minusBacklitLCD.gif
     1017  05-01-02 20:20   periodBacklitLCD.gif
     1047  08-23-02 15:05   plusBacklitLCD.gif
     1056  07-08-02 12:14   zBacklitLCD.gif
 --------                   -------
    20429                   20 files
[oliverm@mcba5:~]
```

G. CDROM directory structure

apt	The base directory for the apt files
cvs-workspace	Build environments for the apt, jas, jcan, jsdt and lib modules as of 4-11-2002
masterswitch	Masterswitch documentation and jsnmp code workspace
searfe	The base directory for the CSIRO searfe project
aor-software	Miscelaneous files and manuals for the AOR-AR3000A receiver
commapi	The Java Communication API for win32 (version 2.0)
visad	The VisAD distribution and documentation
workspace	Build enviroment for the Spectrum Scanner software
thesis	Copies of this document and the diagrams within it